Modline® 5

Series 52, 56, 5G and 5R Sensors

Infrared Thermometer

Operating Instructions

IRCON
A Fluke Company

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The Modline 5 Sensor, POI Box and TSP terminal strip plate have been tested to and meet the following standards:

EN 61326-1:2006	Immunity Test Requirements in Industrial Locations (EMC)
EN 60825-1, 2001	Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use.

Covered by **Patent No.: 5812270** when Dirty Window Detector Option installed.

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1 Safety Instructions

This document contains important information, which should be kept at all times with the instrument during its operational life. Other users of this instrument should be given these instructions with the instrument. Eventual updates to this information must be added to the original document. The instrument can only be operated by trained personnel in accordance with these instructions and local safety regulations.

Acceptable Operation

This instrument is intended only for the measurement of temperature. The instrument is appropriate for continuous use. The instrument operates reliably in demanding conditions, such as in high environmental temperatures, as long as the documented technical specifications for all instrument components are adhered to. Compliance with the operating instructions is necessary to ensure the expected results.

Unacceptable Operation

The instrument should not be used for medical diagnosis.

Replacement Parts and Accessories

Use only original parts and accessories approved by the manufacturer. The use of other products can compromise the operation safety and functionality of the instrument.

Instrument Disposal

Disposal of old instruments should be handled according to professional and environmental regulations as electronic waste.

Operating Instructions

The following symbols are used to highlight essential safety information in the operation instructions:

Helpful information regarding the optimal use of the instrument.

Warnings concerning operation to avoid instrument damage and personal injury.

Incorrect use of 110 / 230 V electrical systems can result in electrical hazards and personal injury. All instrument parts supplied with electricity must be covered to prevent physical contact and other hazards at all times.

2 Product Description

2.1 Modline 5 Sensors, Cable and Interface Accessories.

The basic Modline 5 System consists of either a standard Sensor or Sensor with the Dirty Window Detection option with an interconnecting cable and Terminal Strip Plate. Optional components include the POI Power Supply/Signal Interface Box and the remote DPM Digital Meter operator interface.

2.1.1 Preliminary Inspection

The Modline 5 is delivered in plastic wrappings, cradled in foam inside rugged cartons. The Sensor and any accessories you have ordered are shown on the packing list. The photograph above identifies Modline 5 system components. See Section 3 Sensor Installation, page 22 to identify mounting, air purging, water cooling and other mechanical accessories.

Figure 1: Sensors, Cable and Interface Accessories

Place all items on a workbench or desk before removing the plastic covers. Inspect each item carefully to determine if any damage occurred in transit. If you find such damage, promptly inform the freight agent delivering the components. Save the carton until you are sure you will have no further use for it.

Return items for repair in their original packaging. Contact Ircon before returning any products for service. See Section 7 Maintenance, page 127 on how to contact IRCON.

For Modline 56 sensors: occasionally, a calibration flag that operates during the Sensor internal Calibrate test may move into the viewing area during shipment. If this occurs, the viewing area will be dark and appear obstructed. This flag will be positioned correctly when power is applied to the Sensor.

2.2 Modline 5 Description

The IRCON Modline 5 is an Infrared Thermometer Sensor. State of the art digital circuitry and firmware provide excellent measurement accuracy, repeatability and overall performance. New diagnostics check the status of the Sensor (such as detector temperature, sensor failure) and some of its external environment (such as analog current output open circuit condition and case temperature). An internal function check is performed without the need to block the lens. The check tests for and internal circuit and detector operation. Alarms and Error Codes are outputted when out of limit conditions are sensed.

The Patented Dirty Window Detector option checks the Sensors front window for loss of signal because a build up of contaminants.

An easy to read, bright LED alphanumeric temperature display and three pushbuttons on a keyboard is located at the rear of the Sensor. Each Sensor has a full complement of easy to navigate rear panel setup and operating functions. Operation as a stand alone Sensor is accomplished simply by using its rear panel keyboard to access and setup operating parameters. The Sensor can display and output temperature signals, and operates with an external dc power source.

The Sensor optics and electronics are contained in a small, rugged stainless steel NEMA 4 (IP65) rated housing. Modline 5 accessories for mounting, air purging and cooling the Sensor have been designed to maintain a small installation footprint.

2.2.1 Sensor Standard Features

Through the lens visible rear focusing and sighting with standard or close focus lenses.

Field selected °F or °C measuring units.

Field selectable analog current outputs, 0 to 20 mA or 4 to 20 mA. Temperatures within the span of the Sensor can be assigned to the Analog output Zero and Full scale current values to customize the corresponding output temperature range.

Peak Picker and Track and Hold Signal Conditioning with remote switch input for Peak Picker Reset or Track and Hold operation.

RS-485 Digital Communications allows interfacing with any RS-485 capable device to setup and operate the Sensor remotely. This allows use of a Host computer, Programmable Logic Controller (PLC), etc. with the Sensor

Analog current input for remote adjustment of Emissivity or E-Slope.

Sensor diagnostic Alarm relay contacts are brought out on the interconnecting cable.

2.2.2 Optional Sensor Features

The Dirty Window Detector and Laser Sight are optional features that can be ordered when the Sensor is purchased.

These options are not field upgradeable.

2.3 Model Configuration and Required Selections

2.3.1 Model Configuration

The Modline 5 Model number contains seven alphanumeric characters. The first two designate the Sensor Series. The Series defines the type of Sensor, brightness or ratio, and the operating wavelength.

The next four digits define the Sensor's temperature range and optical resolution with the standard lens installed.

Selection of sight, Visible through the lens or optional Laser aiming, is next. Permanent factory installation is required. Each is exclusive of the other.

The Dirty Window Detector Option (DWD) is the next required selection. Permanent factory installation is required. The product is covered by Patent Number 5812270 when the Dirty Window Option is installed.

A Sensor can also be ordered to be used a Transfer Standard to calibrate other Modline 5 Sensors. ModView Calibration Software and an expanded Calibration Certificate is supplied with this Sensor Model.

A lens selection is required. Lens types for each Sensor must be specified. Lenses are factory installed and are not field changeable.

Series designation, temperature range, optical resolution, optional Laser and DWD information is provided in the tables sections below. Lens focusing ranges are found in Section 3.4 Sensor Optical Characteristics, page 26. Ordering information and Model Number examples follow the tables.

Two Digit Sensor Series Designation

Sensor Series	Sensor Type Spectral	Response in µ (microns)
52	Brightness	0.85 to 1.1
56	Brightness	Lowest Temperature Range 2.0 to 2.8 Other Ranges: 2.3 to 2.6
5G	Brightness	1.6
5R	Selectable Modes: Ratio or Brightness (1 Color Mode)	Ratio Mode: 0.75 to 1.05; 1.0 to 1.1 Brightness Mode: 1.0 to 1.1

Series 52: Sensor Model Numbers

Model	Temperature Range in °C and (°F)	Optical Resolution with Type 2A Lens
52-1410	500 to 1400°C (932 to 2552°F)	D/100
52-2020	600 to 2000°C (1112 to 3632°F)	D/200
52-3024	750 to 3000°C (1382 to 5434°F)	D/240

Series 56: Sensor Model Numbers
Emissivity span is limited to 0.3 to 1.0 for the first 55°C (100°F) for all temperature ranges

Model	Temperature Range in °C and (°F)	Optical Resolution with Type 6A Lens
56-0315	50 to 300°C (122 to 572°F)	D/150
56-0415	100 to 400°C (212 to 752°F)	D/150
56-0815	200 to 800°C (392 to 1472°F)	D/150

Series 5G: Sensor Model Numbers
Emissivity span is limited to 0.3 to 1.0 for the first 55°C (100°F) for all temperature ranges

Model	Temperature Range in °C and (°F)	Optical Resolution with Type 2A Lens
5G-1007	250 to 1000°C (482–1832°F)	D/75
5G-1415	300 to 1400°C (572–2552°F)	D/150
5G-2024	350 to 2000°C (662 – 3632°F)	D/240

Series 5R: Sensor Model Numbers

Model	Temperature Range in °C and (°F)	Optical Resolution with Type RA Lens
5R-1410	600 to 1400°C (1112 – 2552°F)	D/100
5R-1810	700 to 1800°C (1292 – 3272°F)	D/100
5R-3015	1000 to 3000°C (1832– 5432°F)	D/150

Through the Lens Sight – Required Selection

Visible or Optional Laser Sighting.

Lens Types
Lens selection requires matching the lens to specific models. Lens types ending in A are considered standard focusing range lenses. Lens types ending in B are considered close focus lenses. Lens types ending in C are considered very close focus lenses. Complete lens focusing ranges and spot size information are found in Section 3 Sensor Installation, page 22 of this manual.

Dirty Window Detector Option – Required Selection,
The selection is Installed or None. The product is covered by Patent Number 5812270 when the Dirty Window Detector Option is installed.

2.4 Modline 5 Model Number Summary

Modline 5 Model Number as Found on Serial Number Label

Series	Model	Sighting: Visible or Laser	DWD None or Installed	Transfer Standard	Lens Type
(Two Characters)	(Four Digits)	0 or 1	0 or 1	0 or T	(Two Characters)

Example and Explanation

5 R	1 4 1 0	1	1	0	RA Lens
5R	600 to 1400°C D/100	Laser Sight	DWD Installed	This unit is not a Transfer Standard	Focusing Range: 13 inches to infinity D/100

The Model Number explanation information provided above defines a Modline 5 Sensor having the following characteristics and features:

- Model 5R-1410 is a Series 5R Ratio Type Sensor with the temperature range of 600 to 1400°C (1112 to 2552°F) and D/100 Resolution.
- The Sensor Sight is Laser through the lens (Visible sighting was not selected).
- The Dirty Window Detector Option (DWD) is installed
- The Sensor is not a Transfer Standard. (T = Transfer Standard)
- The installed lens is for the 5R Series and provides the standard focusing range of 13 inches to infinity. The Sensor Model and lens combination provide a D/100 Optical Resolution

2.5 Accessories

2.5.1 Interconnecting Cable – Required Accessory

An IRCON supplied interconnecting cable with the Sensor mating connector attached on end one and termination prepared wires on the other end is required. Special assembly of the cable is required and the cable is only sold with the Sensor connector attached.

Maximum cable length is 350 feet (107 meters). The cable length limitation is due to the power supply voltage requirements of the Sensor. The power supply voltage drop across this length of cable are low enough to provide proper Sensor operation. Power supply cable wires are 22 AWG (0.35 mm^2). Input and Output wires are 24 AWG (0.25 mm^2).

RS-485, Alarm relay output, and analog outputs, can extend beyond the 107 meter limitation. See Section 4 Sensor Wiring, page 62 for more information.

The cable must be terminated into a POI – Power Supply/Signal Interface Box or a TSP – Terminal Strip Plate to ensure that the Sensor and cable installation meets RF immunity and emission standards for CE compliance. These items are described below.

2.6 Power and Interface Accessories

Model POI – Power Supply/Signal Interface Box.
This box includes a 24VDC power supply and interconnecting cable termination strip. Input power is 100 to 240 VAC 50/ 60 HZ, 15 Watts maximum.

Model TSP – Terminal Strip Plate
This plate includes an interconnecting cable termination strip and suppression components.

Model DPM – Digital Panel Meter
Digital Temperature Indicator and RS-485 Communication Operator Interface. 85 to 250 VAC 50/ 60 HZ, 15VA. The DPM does not provide power to Sensor.

2.7 Installation Accessories

Details on the following standard accessories can be found in Section 3 Sensor Installation, page 22. An extended family of accessories is available and they are referenced in Section 3.

Standard Modline 5 Accessories

Model – MFS	Mounting Flange (Small Diameter Pattern)
Model – BMA	Base Mount Adapter
Model – APA	Air Purge Accessory
Model – WJA	Water Jacket Accessory
Model – ESA	Dirty Window Detector Extension Sleeve Adapter (one included with Dirty Window Detector Option)
Model – UAA	Universal Accessory Adapter
Model – MFL	Mounting Flange Large
Model – RAM	Right Angle Mount
Model – M5WJ5	Mounting Kit to mount Sensor in WJ-5 Water Cooling Jacket

Protective Window / Sight Accessory

The EP – 5 with a dimming filter is available for viewing very high temperatures. This window replaces the standard rear protection / sight window supplied with the Sensor. This filtered window is for viewing high temperature targets from 1200°C (2192°F) to 2300°C (4172°F).

Spare part standard protection windows are identified as the RPW, rear protection window assembly with clear sight window. One of these is supplied with every Sensor.

2.8 Specifications[1]

2.8.1 Sensor Specifications

Spectral Response

Series 52	0.85 to 1.1 microns
Series 56	2.0 to 2.8 microns (Model 56 to 0315 only) 2.3 to 2.6 microns (All other models)
Series 5G	1.6 microns
Series 5R	Ratio Mode: 0.75 to 1.05; 1.0 to 1.1 microns
Single Color Brightness Mode	1.0 to 1.1

* All specifications subject to change without notice.

Calibration / Blackbody Accuracy at 25°C

Sensor Series 52	Within 0.3% of reading plus 1°C up to 2800°C (5072°F) indication up to 3000°C (5432°F)
Sensor Series 5G	Within 0.3% of reading plus 1°C
Sensor Series 56	Within 0.3% of reading plus 1°C, or 2C (whichever is greater)
Sensor Series 5R	Within 0.5% of reading plus 2°C up to 2800°C (5072°F) indication up to 3000°C (5432°F)

Repeatability at 25°C Within 0.1% of full-scale temperature (+1 digit)

Response Time for Display and Outputs

Series 5R	Adjustable from 0.01 to 60 seconds.
Series 52, 5G	Adjustable from 0.0066 to 60 seconds.
Series 56	Adjustable from 0.020 to 60 seconds.

Selectable Analog Current Output 0 to 20 mAdc or 4 to 20 mAdc
600 Ω maximum load including cable resistance
Output is not isolated from power supply common.

Digital Communications RS-485 Digital Interface

Emissivity Range Emissivity is 0.10 to 1.00.
Series 52, 56, 5G and 5R (single color mode)

Emissivity Limitations for Series 5G and 56

Emissivity span is limited to 0.3 to 1.0 for the first 100°F (55°C) for all temperature ranges of these models

E-SLOPE Range Model 5 R (Two color Ratio Mode) 0.800 to 1.200.

Signal Reduction Range Tolerated Sensor Series 5R will tolerate 95% reduction in radiation intensity caused by low emissivity, non-resolved or obscured

[1] All specifications subject to change without notice.

	targets or combinations of these conditions above target temperatures of 1500°F (800°C).
System ALARM Relay Contacts	24 V AC/DC at 1 Amp. Resistive
Peak Picker Rise Time	Same as selected Response Time
Peak Picker Decay Rate	Adjustable 0.00 to 300 degrees F (0.00 to 166 degrees C) per second
Peak Picker Reset:	Internal Reset has two Modes: Manual and Auto. External Reset: Contact closure greater than .08 second
Track and Hold	Tracking Mode is elected with external contact closure
Power Requirements	24 VDC +/- 5%, 8 Watts Maximum
Operating Ambient Temperature	
Sensor Series 52, 56, 5R and 5G:	0 to 55°C F (32 to 130°)
With WJA Accessory Air Cooling	0 to 105°C (32 to 220°F)
With WJA Accessory Water Cooling:	0 to 200°C (32 to 400°F)
Sensor Environmental	
Sensor Housing	NEMA 4 (IP65).
Sensor Cable Plug and Housing Connector	NEMA 4 (IP65).
Humidity	10 to 90% non-condensing
Sensor Dimensions	See dimensional drawings in Section 3 Sensor Installation, page 22 of this manual.
Weight	4 lbs (1.8 kg) approximate, Model and option dependent
Laser Sight Option	Laser: Class II Less than 1 mw at 635 nm
Shock	IEC 68 - 2-27
Vibration	IEC 68 -2-6

See the first manual pages for CE information for Modline 5 Sensor and POI Box.

2.8.2 Accessory Specifications

POI Power Supply/Signal Interface Box

Ambient Temperature: 0 to 55°C (32 to 130°F)
Environmental: NEMA 4 (IP65)
Power Requirements: 100 to 240VAC 50/ 60 HZ, 40 VA.

DPM Digital Panel Meter

Ambient Temperature: 0 to 50°C (32 to 122°F)
Environmental: NEMA 4X (IP65) Sealed Front Bezel
Power Requirements: 85 to 250 VAC 50/60 HZ, 15VA.

Terminal Strip Plate

Ambient Temperature: 0 to 55°C (32 to 130°F)

Sensor Standard Teflon Interconnecting Cable

Maximum temperature: 200°C (392°F)

Maximum cable length: 107 meters (350 feet)

See the first manual pages for CE information for Modline 5 Sensor and POI Box.

See Red Lion Bulletin PAX – P for completing the specifications for DPM.

3 Sensor Installation

3.1 Mechanical Installation

This section provides instructions for installing the Modline 5 Sensor. Sighting, aiming, focusing and resolving targets are explained. Mounting and protection of the Sensor in hot and dirty environments using installation, air purging and water cooling accessories are presented.

3.2 Sensors

Figure 2: Standard Sensor

Figure 3: Sensor with Dirty Window Detector

Two Sensors types are available in the Modline 5 Series, standard Sensor or Sensor with the Dirty Window Detector option. The front of the standard Sensor consists of a front objective lens only. The Sensor with the Dirty Window Detector option has internal components and an external protection window located in front of the objective lens. A hooded mirror extends out in front of protection window. The sensors are illustrated in the photographs above and below.

The Patented Dirty Window Detector option, IRCON, inc. Patent Number 5812270, checks the Sensors front window for loss of signal caused by a build up of contaminants. A Coarse or Sensitive level of signal loss can be selected. Visual Alarms and a relay output are provided to indicate window contamination.

Dimensions for the Sensor with the DWD is slightly different because of the additional components. Measurement of the optical working distance on the standard Sensor is made from the front surface of the unit. The working distance determination on the Sensor with DWD requires a simple calculation. Measurement is made from the front tip of the hooded mirror and 66 mm (2.6 inches) is added to the distance to compensate for the extended optics.

Figure 4: Standard Sensor Lens and Lens with DWD

3.2.1 Sensor Parts

The photograph below illustrates the Sensor parts called out in this manual.

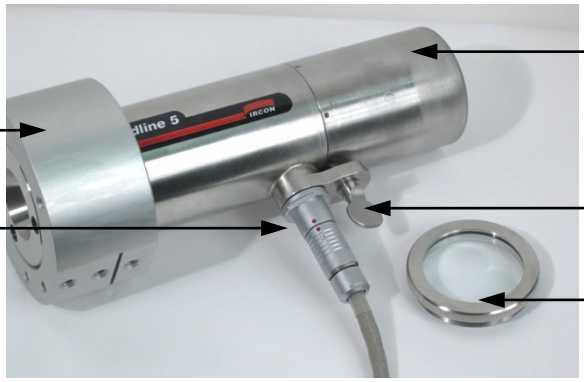


Figure 5: Sensor Parts

The EP – 5 Protective / Visual Sight Window with a dimming filter is available for viewing very high temperatures. This replaces the standard rear protection and sight window shown above.

3.3 Sighting Methods

The Modline 5 Sensor is a precision electro-optical instrument that senses infrared radiation. This signal is processed by the unit's digital circuits to provide an output proportional to the temperature being measured. The Sensor's linear analog current output and RS-485 digital temperature signals are brought out through a connector on the bottom of the Sensor with a shielded cable. The output signals are then connected to compatible devices within the process measurement system.

3.3.1 Sighting and Focusing

The Modline 5 is a variable focus instrument that features visual through-the-lens sighting by means of a viewing sight at the rear panel of the Sensor. An optional internal Laser for through-the-lens aiming is available. Focusing with either the visible or laser sight is accomplished using the rotating rear section of the Sensor.

3.3.2 Visual Sight

The Modline 5 visible sight is aimed and focused onto the target to be measured as simply as an ordinary camera. The rear focus is smooth, utilizing almost one turn of the focusing section.

A circular reticle is contained within the Sensor's optical system and is visible when viewing through the sight. During temperature measurement, the target image is superimposed on the reticle. Focusing is performed by adjusting the rear focusing section while viewing the scene until the target area is clear and well defined. Illustrated below is a properly focused Sensor viewing an induction heated rod. The visible sight rear panel is shown below.

Figure 6: Visible Sight

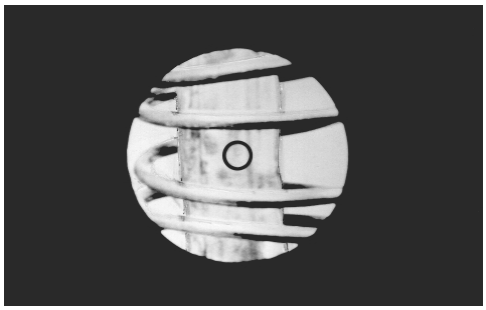


Figure 7: Reticle

When properly focused, the area of the target within the reticle will be measured. The Sensor infrared detector will "see" the same image seen defined by the reticle. Approximately 97% of the measured energy will come from the area defined by the reticle.

To check or adjust focus, slowly move your head slightly from side to side or up and down. Note whether the target appears to move with respect to the reticle. If it does, adjust the lens focusing section, until there is no perceived motion between the reticle and target (hence eliminating parallax between the two). The instrument is then in sharp focus. Lock the lens rear focusing section in place using the locking thumbscrew on the bottom of the Sensor.

If looking through a sight tube or sight hole, position, align and rotate the Sensor and Sight tube to center the reticle in the field of view.

For Modline 56 sensors: occasionally, a calibration flag that operates during the Sensor Calibrate test may move into the viewing area during shipment. If this occurs, the viewing area will be dark and appear obstructed. This flag will be positioned correctly when power is applied to the Sensor.

3.3.3 Laser Sight

With the optional Laser sight, a laser light spot is projected onto the target and used to aim the Sensor. The same rear focusing method applies and is to be used to adjust for the smallest laser light spot. The projected focused laser image will be approximately the same diameter "spot" as measured by the detector. See Section 3.4 Sensor Optical Characteristics, page 26 for determining spot size.

The Laser image is reflected from the target surface. The image can easily be seen on most targets at distances of 10 feet and further. The visibility of the reflected image is dependent on the reflection characteristics of the target material as well as the intensity of the ambient lighting. When viewing hot glowing targets, the visibility of the image also depends upon its temperature. The color and intensity of a hot glowing object may override the reflected Laser image.

Use of the laser on distant targets or poorly reflecting targets may require some white paint on the target or a white substitute target such as a sheet of paper to accomplish focusing. Ambient light dimming may be required for targets that reflect poorly. For difficult conditions, pre-focus the Sensor optics while aiming the laser at a white reflective target. Then use the Laser to aim the pre-focused Sensor on to the target.

Figure 8: Laser Sight

If looking through a sight tube or sight hole, position, align and rotate the Sensor and Sight tube to center the laser image in the field of view.

The Sensor is a Class II Laser Product with the Laser Sight option installed, see section 5.11 Laser Sighting Operation, page 110 of this manual for safe and full operating instructions. Install Sensor and setup Laser operating procedures so that personnel are not exposed to the laser beam at any time whether the Laser is energized remotely or at the Sensor Rear Panel.

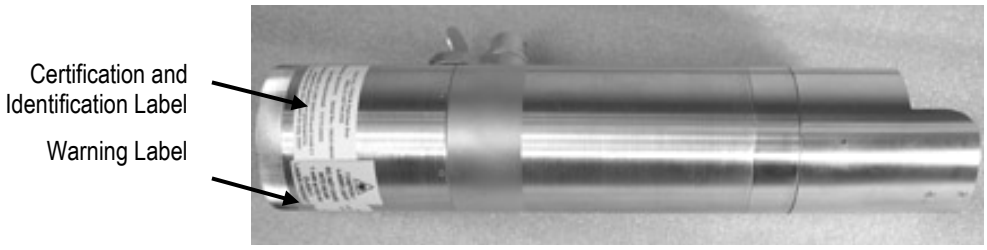


Figure 9: Sensor Laser Labels

These two Sensor Laser labels are shown in detail in Figure 10.

Figure 10: Sensor Laser Labels in Detail

3.4 Sensor Optical Characteristics

3.4.1 Optical Resolution

The Sensing Head is sensitive to infrared radiation in the area indicated by the Cone of Vision in the illustration below.

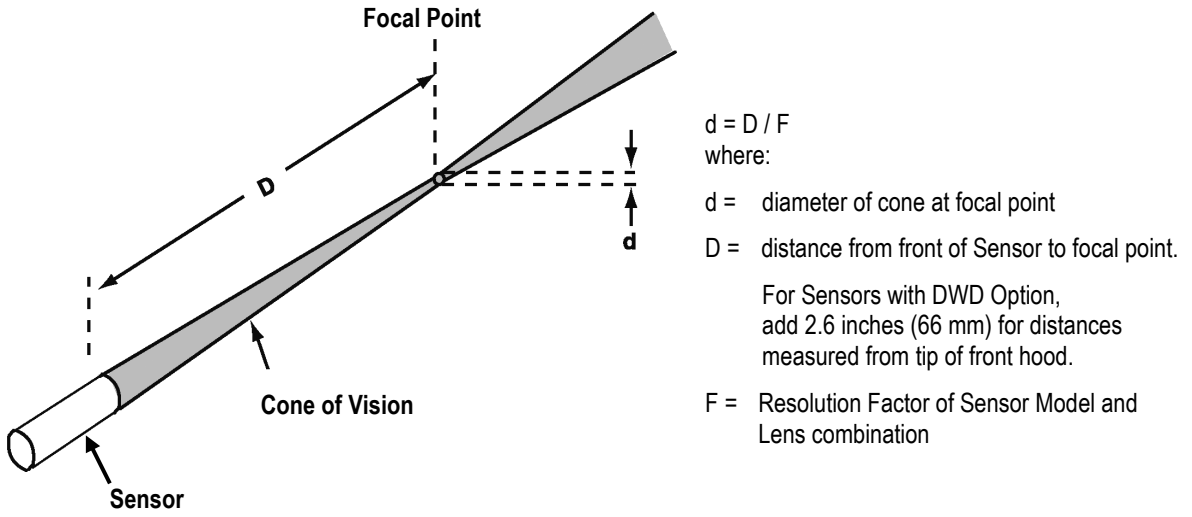

Focal Point
D
d
Cone of Vision
Sensor
d = D / F
where:
d = diameter of cone at focal point
D = distance from front of Sensor to focal point.
For Sensors with DWD Option, add 2.6 inches (66 mm) for distances measured from tip of front hood.
F = Resolution Factor of Sensor Model and Lens combination

Figure 11: Cone of Vision and Spot Size Formula

The diameter of the cone at any point will determine the area of measurement at that point. Any part of the target or other intervening object positioned within the cone will be imaged on the detector. Anything seen by the detector will become part of the measurement.

When the Sensor is sighted on an object, you are "aiming" or positioning the cone of vision on the object. When you focus, you are adjusting the optical system elements so the focal point is at the surface of the object. The measurement area, as seen by the detector, will then be outlined in the reticle. The reticle only defines the measured area (spot size) in the focused condition.

The formula d = D/F defines the spot size at the focal point. Simply divide the Working Distance (D), measured from the front of the Sensor to target by the Resolution Factor (F) to determine the Spot Size (d). Resolution factors for Sensor Model and Lens combinations are provided in the table on the following page. The focusing range for each lens type is also provided in the table. The focusing range defines the allowable range for the Working Distance.

For Sensors with the Dirty Window Detector Option, the Working Distance (D) is calculated by measuring the distance from the front tip of the protruding hood to the target and then adding 2.6 inches (66 mm).

3.4.2 Lens Focusing Ranges and Optical Resolution Factor

The table below lists Lens Type and Focusing Ranges for the Modline 5 Series 52, 56, 5G and 5R. Two ranges are shown. The first range is for a Sensor without the Dirty Window Detector Option (DWD) option. The distance is measured from the front metal surface of the standard Sensor.

The second range is for a Sensor with the DWD option. This distance is measured from the tip of the front mirror hood. Very close lens types that include alpha character C are not useable with the DWD option.

Some installation, cooling and air purging accessories will limit some of the usable close focus range accessory.

The Model number and installed lens type is found on the Sensor Model number tag. Range tolerance of is ±10%.

3.4.3 Table of Model and Lens Type Combinations with Focusing Ranges

The Optical Resolution Factor for each Model and Lens combination is given in the table. Use the formula: d = D / F to calculate the spot size at any working distance within the specified range. The smallest spot size can be determined using the closest distance within the range.

Model Number	Lens Type	Focusing Range in inches " and millimeters (mm)		Resolution Factor
		Standard Sensor	Sensor with DWD Option	
52-1410, 5G-1007	2A	13" to infinity (330 mm to infinity)	10.4" to infinity (264 mm to infinity)	D/100, D/75 (5G)
52-2020, 5G-1415	2A	13" to infinity (330 mm to infinity)	10.4" to infinity (264 mm to infinity)	D/200, D/150 (5G)
52-3024, 5G-2024	2A	13" to infinity (330 mm to infinity)	10.4" to infinity (264 mm to infinity)	D/240
52-1410, 5G-1007	2B	6 to 12 " (152 mm to 305 mm)	3.4 to 9.4" (86 to 239 mm)	D/90, D/67 (5G)
52-2020, 5G-1415	2B	6 to 12 " (152 mm to 305 mm)	3.4 to 9.4" (86 to 239 mm)	D/180, D/135 (5G)
52-3024, 5G-2024	2B	6 to 12 (152 mm to 305 mm)	3.4 to 9.4" (86 to 239 mm)	D/216
52-1410, 5G-1007	2C	2.25 to 2.75" (57 to 70 mm)	Not Available with this lens.	D/80, D/60 (5G)
52-2020, 5G-1415	2C	2.25 to 2.75" (57 to 70 mm)	Not Available with this lens.	D/160, D/120 (5G)
52-3024, 5G-2024	2C	2.25 to 2.75" (57 to 70 mm)	Not Available with this lens.	D192
56 – All Models	6A	12" to infinity (305 mm to infinity)	9.4" to infinity (239 mm to infinity)	D/150
56 – All Models	6B	6 to 12 " (152 mm to 305 mm)	3.4 to 9.4" (86 to 239 mm)	D/ 135
56 – All Models	6C	2.25 to 2.75" (44 to 57 mm)	DWD Not Available with this lens.	D/105
5R-1410, 5R-1810	RA	13" to infinity (330 mm to infinity)	10.4" to infinity (264 mm to infinity)	D/100
5R-3015	RA	13" to infinity (330 mm to infinity)	10.4" to infinity (264 mm to infinity)	D/150
5R-1410, 5R-1810	RB	7 to 14" (178 mm to 355 mm)	4.4 to 11.4" (112 to 289 mm)	D/90
5R-3015	RB	7 to 14" (178 mm to 355 mm)	4.4 to 11.4" (112 to 289 mm)	D/135
5R-1410, 5R-1810	RC	2.25 to 2.75 " (57 to 70 mm)	Not Available with this lens.	D/80
5R-3015	RC	2.25 to 2.75 " (57 to 70 mm)	Not Available with this lens.	D/120

Table 1: Model and Lens Type Combinations with Focusing Ranges

3.4.4 Spot Size and Viewing Distance

Viewing distance and spot size is demonstrated in the Distance and Spot Size illustration. A Sensor with a Resolution Factor of F = 100 is focused on a 0.5 inch (12.7 mm) rod at three distances. The drawings at the left for each example illustrate a large circle that represents the total area visible in the Sensor sight. The smaller circle represents the reticle.

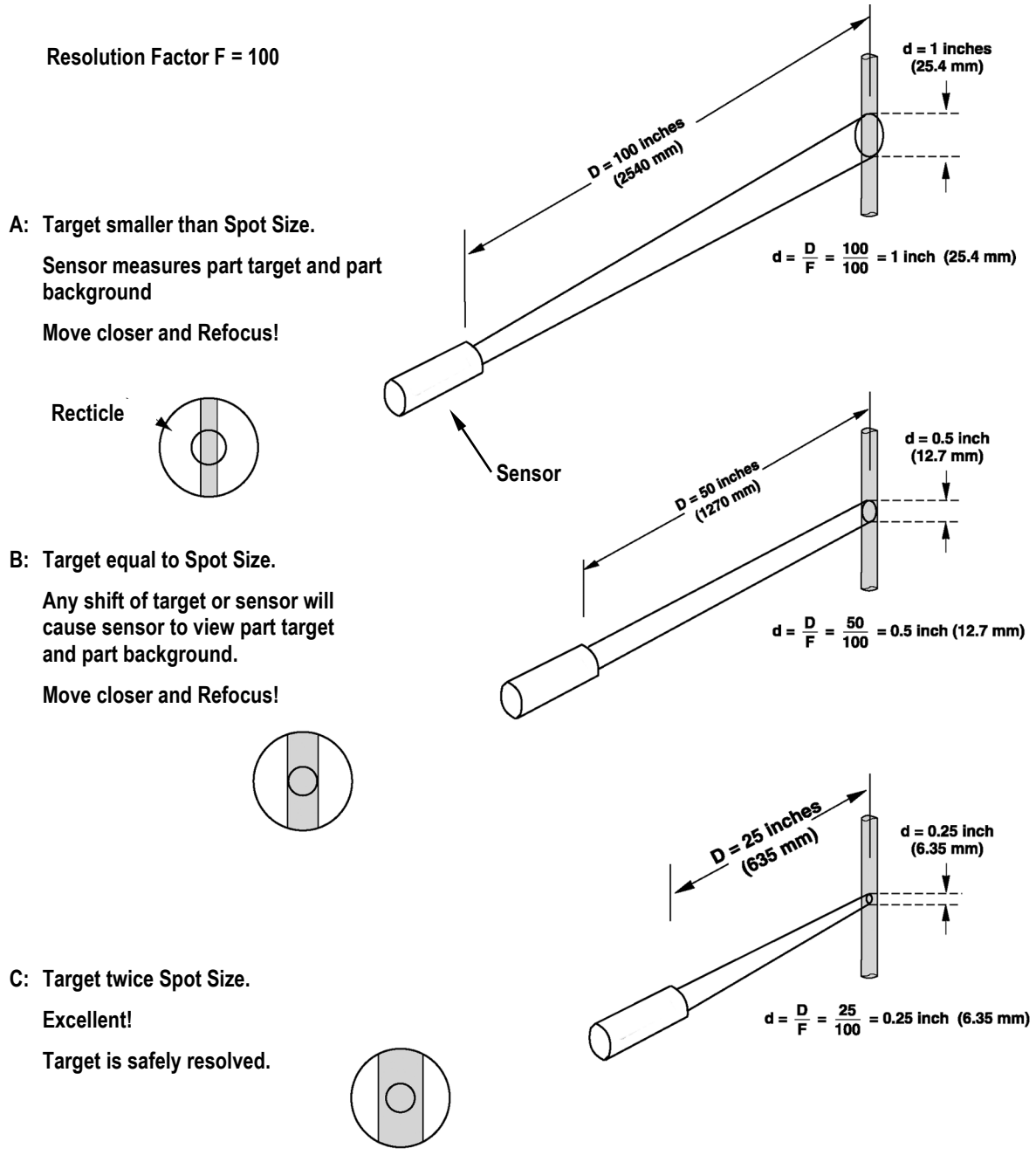

Resolution Factor F = 100
A: Target smaller than Spot Size.
Sensor measures part target and part background
Move closer and Refocus!
Recticle
D = 100 inches (2540 mm)
d = 1 inches (25.4 mm)
d = D/F = 100/100 = 1 inch (25.4 mm)
Sensor
B: Target equal to Spot Size.
Any shift of target or sensor will cause sensor to view part target and part background.
Move closer and Refocus!
D = 50 inches (1270 mm)
d = 0.5 inch (12.7 mm)
d = D/F = 50/100 = 0.5 inch (12.7 mm)
C: Target twice Spot Size.
Excellent!
Target is safely resolved.
D = 25 inches (635 mm)
d = 0.25 inch (6.35 mm)
d = D/F = 25/100 = 0.25 inch (6.35 mm)

Figure 12: Distance and Spot Size Illustration

In top example A, the rod is 100 in. (2540 mm) away. The spot is 1 inch (25.4 mm) in diameter. The one half inch diameter rod does not fill the reticle in the viewing sight. Middle example B illustrates a viewing distance of 50 inch (1270 mm). The spot is 0.5 inch (12.7 mm) in diameter, the same size as the rod. Bottom example C illustrates a viewing distance of 25 inch (635 mm). The spot size is 0.25 inch (6.35 mm) one half the one half inch target size. The view in the eyepiece shows the target completely resolved by the reticle.

3.5 Measuring Temperature with Brightness and Ratio Sensors

3.5.1 Resolving Targets with Brightness Sensors

When using single color Series 52, 56 and 5G brightness Sensors, best results are obtained when the resolved portion of the target is two times the diameter of the reticle.

The Sensor measures the average temperature of the target or object seen in the reticle. Targets smaller than the reticle will result in low temperature readings if the background (object within the cone of vision beyond the target) is lower that the target temperature. If the background temperature is higher than the target, the averaged temperature indication will be higher.

Low temperature indications can also be caused by other factors. An out of focus cool object cutting the cone of vision anywhere between the target and Sensor, or a small target may shift position and move partially out of the measurement cone.

3.5.2 Obstructions in Cone of Vision

Errors can be caused by objects positioned between the Sensor and target. Evaluate the Sensor's "Cone of Vision" and if there is any possibility that an intervening object is within the cone, select a different viewing position. An object inside the Cone of Vision will be visible to the detector and may cause an error in the temperature measurement. Obstructions in the cone of vision, whose temperatures are lower than the target temperature, will generally cause lower temperature readings when using single color brightness units. The obstruction may not be seen clearly in the instrument sight if it is some distance away from the target and out of focus. Such an obstruction is illustrated below.

High temperatures can be caused by an out of focus hot object cutting the cone of vision anywhere between the target and Sensor.

Two color ratio units are usually not affected by obstructions that are significantly lower in temperature than the target. Ratio units are affected by hot objects in the cone of vision that are much higher in temperature than the target. If too high, the hot targets can dominate the measurement. If the object temperature is the same, the measured temperature is not affected.

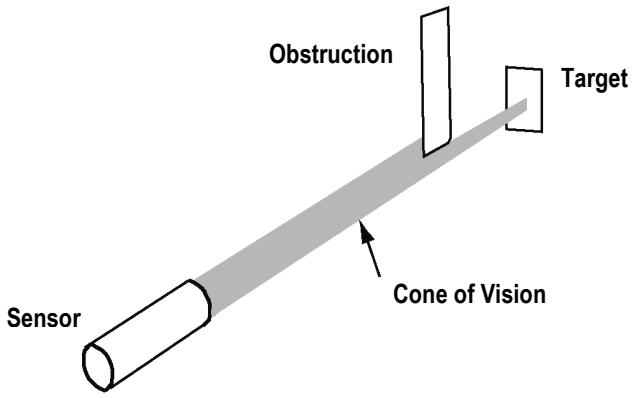


Figure 13: Cone of Vision Obstruction

3.5.3 Resolving Targets with Two Color Ratio Sensors

Modline 5 Series 5R Ratio Sensors utilize a dual detector assembly that measures temperature by comparing infrared radiation levels in two wavelength bands (0.85 to 1.05 microns and 1.0 to 1.1 microns). Temperature readings are based on the ratio of the two signals in these bands.

Because Series 5R Sensors measure the ratio of radiation intensities at two wavelengths rather than the absolute intensity of radiation at a single wavelength, they are almost immune to error caused by loss of signal. Small targets that do not fill the field of view and partial obstructions from bursts of steam, dust and solid objects in their sight path can be tolerated.

3.5.4 Signal Reduction

Three causes contribute to the loss of signal:

- Low target emissivity.
- The measured object is too small to fill the reticle as seen in the Sensor sight and is not completely resolve.
- Partial obstruction of the optical path caused by smoke, steam, dust, dirty window or a solid object.

The total reduction in signal is the sum of the losses from all three causes.

Example: Assume the target emissivity is 0.45. The reduction in signal due to low emissivity is 55%. If the instrument can operate with a 95% signal reduction, another 40% can be lost due to an unresolved target and/or obstructions in the cone of vision such as smoke, steam, dust, a dirty window or partial blockage by solid objects.

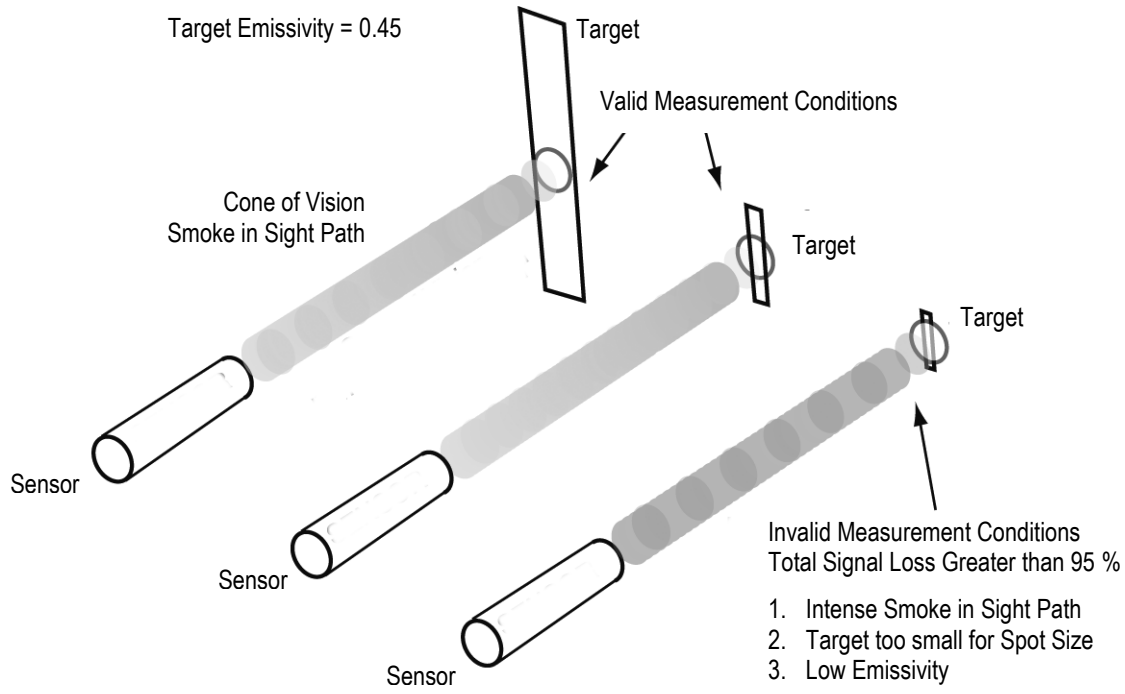


Figure 14: Invalid Measurement Conditions

When you reach the maximum allowed reduction, the Sensor will indicate "Invalid". An Invalid measurement condition also occurs, without any obstructions, if the target temperature signal is below a level that can be accurately measured by the instrument.

Signal Reduction Tolerated

The Series 5R Sensors have a limit as to how much the signal from a hot target can be reduced. The reduction in the signal can be as high as 95% with target temperatures above 800°C (1500°F). The amount of signal reduction that the Series 5R Sensors will tolerate depends upon the Sensor

temperature range and the target temperature. The signal reduction tolerated is less in the bottom portion of the range. The Sensor will indicate invalid when the measurement is not possible.

3.5.5 Summary

The spot size and target size relationship is not as critical for Series 5R Sensors which use the two color ratio method. Avoid emitted radiation from objects in the same field of view (cone of vision) either in the foreground or behind the target that are at temperatures hotter than the target. Reflected or emitted radiation from these interferences can cause measurement errors. Significantly cooler objects, well below the target temperature, will not cause measurable errors.

For best results, brightness sensors that measure radiation intensity at a single wavelength should be installed so the target area is larger than the instrument spot size. If possible, adhere to the target size is twice the spot size rule for all types of instruments.

3.6 Sensor Installation Planning

Mechanical Installation of the Modline 5 Sensor requires determining sighting and focusing requirements, locations for installing Sensors, accessories and cable routing. Planning also includes evaluating environmental conditions that may cause contamination of the Sensor optics or overheating of the Sensor or other Modline 5 components. Re-location of the installation or air purging and water cooling accessories may be required to overcome adverse conditions.

Pre-focusing the Sensor's optical system may be necessary if the Sensor is to be mounted in a difficult location and not accessible. Pre-focus by setting up a well defined target such as a printed page at the exact distance of the target, then lock the rear focusing section.

Setup of the Sensor parameters can also be pre-determined and set before installation.

The following guidelines will help you in planning the Sensor installation.

Mechanical Mounting Location Requirements
The Sensor is installed using the mounting brackets and flanges, air purging and water cooling accessories illustrated in the Section 3.9 Modline 5 Mounting, Cooling and Air Purging Accessories, page 35.

Sensor Mounted to Earth Ground Potential
If the proposed mounting surface is at Earth Ground potential, you can mount the housing directly to this surface. If the surface is not at Earth Ground potential, electrical insulating material and non-conducting hardware must be used to isolate the Sensors. See Section 4.11 Installing and Wiring the Chassis Mount 24 Volt DC Switching Power Supply, page 80 for more information.

Sensor Interconnecting Cable Length
Maximum cable length between the Sensor and the POI Power Supply/Signal Interface Box or Terminal Plate is 350 ft (107 m). Maximum temperature rating of the Sensor Interconnecting cable is 200 °C (392 °F). Plan the cable route accordingly.

Ambient Temperature Limits for Sensor, POI Box and Terminal Strip Plate
The ambient temperature at the mounting locations for the Sensor, POI Power Supply/Signal Termination Box and The Terminal Strip Plate must be between 0 and 55°C (32 and 130°F).

If the ambient temperature at the mounting location is beyond these limits, precautions must be taken to protect the Sensor. A WJA Water and Air Cooling Jacket is available for protection against excessive temperatures. Use of insulation and reflective shielding for additional protection from

extreme ambient temperatures and radiated heat are described in Section 8 Applications Guide, page 137.

The POI Power Supply/Signal Termination Box and The Terminal Strip Plate must be re-located to a location that the ambient temperature is between 0 and 55°C (32 and 130°F).

Lens Protection
Be sure the lens is protected from contamination and is accessible for maintenance. If dust, oil, vapors, etc. collect on the lens, low temperature indications will result. Use an APA – Air Purge Accessory to maintain a clean lens. Consider use of a Sensor with the Dirty window if errors caused by lens contamination can seriously affect the process.

Focal Limits
To permit focusing, the target distance must be within the focal range of the objective lens. Ranges for the Modline 5 objective lenses are given in Section 3.4 Sensor Optical Characteristics, page 26. Range limitations for close focus lenses may be encountered with the use of certain mechanical accessories.

Use of Windows
If it is necessary to view the object through a window, as is the case when the object is being heated in a vacuum or inert atmosphere, correctly select the window material. The material must have constant transmission characteristics in the operating wavelength range of the Sensor type being installed. Information on windows is provided in Section 8 Applications Guide, page 137 of this manual.

Reflections
Reflections from radiating objects represent a potential source of error in temperature measurement. The total radiation seen by the Sensor will be a combination of intrinsic, emitted, radiation plus reflected radiation from a nearby hot object off the target surface.
Examples of interfering sources are hot furnace walls and heating elements that are hotter than or nearly as hot as the target object.

Most reflection problems can be eliminated by changing the viewing angle or shielding the reflections. Suggestions for anticipating and eliminating common reflection problems are provided in Section 8 Applications Guide, page 137.

Indirect Viewing
In some situations, it may be necessary to view the target indirectly by means of a mirror. The characteristics of the mirror, and the positioning of both the Sensor and mirror are critical in this type of arrangement. Refer to Section 8 Applications Guide, page 137 for more information.

Viewing Angle
Viewing angles are limited in some situations. Guidelines are provided in Section 8 Applications Guide, page 137.

3.7 Sensor Mechanical Installation

3.7.1 Installation Accessories

The Modline 5 Sensor requires the use if one or more installation accessories to mount, align and aim the Sensor. The installation accessories also provide for cooling the Sensor and air purging the optics to keep them free from contamination.

Presentation of accessories and sensor installation is organized in the Sections below as follows.

- Sensor dimensions and specifications.
- General requirements for all installations including cable clearances, access for aiming, focusing and setup.
- Description of each accessory accompanied by dimensions and specifications.
- A table of recommended accessory groupings.
- Illustrations of the groupings accompanied by overall dimensions.

Other accessories such as pipe mounts, sight tubes, target tubes window assemblies, etc. are referenced at the end of this section.

3.7.2 Sensor Dimensions

The dimensions of the Standard and Dirty Window Detector Modline 5 Sensors are given below. These dimensions are without any mounting accessories.

Figure 15: Standard Modline 5 Sensor

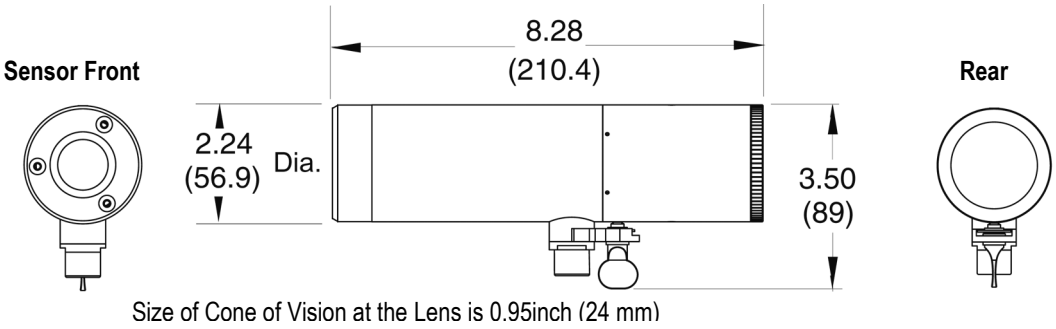


Figure 16: Dimensions Standard Sensor

Figure 17: Sensor with Dirty Window Detector (DWD)

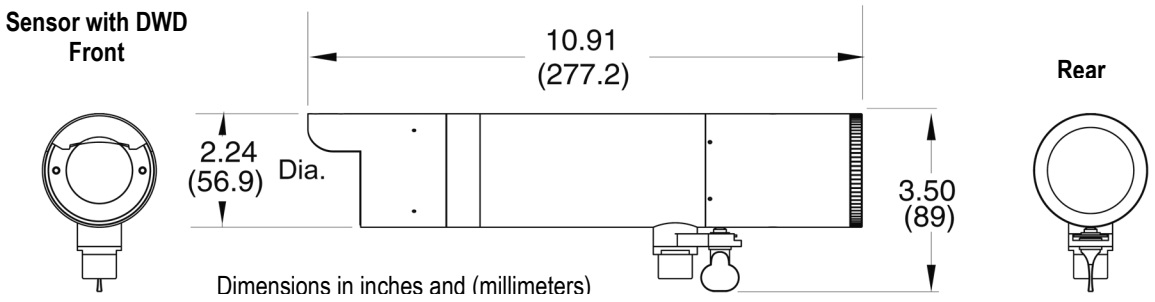


Figure 18: Dimensions Sensor with DWD

3.7.3 General Installation Requirements

- Sensor should be mounted to provide a minimum of 4 inch (101.6 mm) clearance from the housing for connecting the cable.
- Gently bend the cable into its routing position as shown in the photo below.
- Minimum cable bend radius is 3 inches (76.2 mm).
- Rotate the Sensor to avoid cable obstructions.
- Positioning of any mounting accessory on the Sensor should be as close to the front lens as possible without extending beyond it. Some accessories require clamping towards the middle of the body.
- Never clamp on the Dirty Window Detector hooded mirror or the DWD section! (Not shown)
- Never clamp on the rear focusing section of the Sensor.

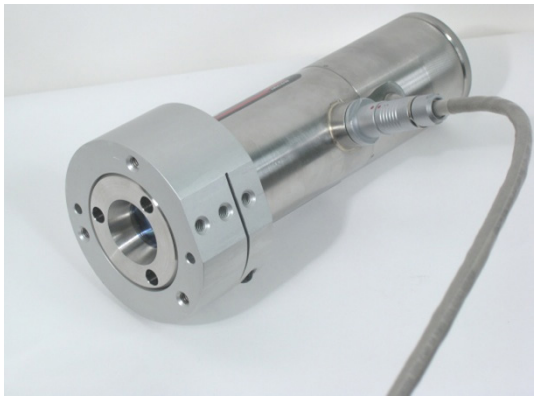


Figure 19: Interconnecting Cable

3.8 DWD Installation Requirements

The Sensor with the Dirty Window Detector option requires the use of an ESA – Extension Sleeve Adapter accessory along with other Modline 5 accessories. The ESA, combined with other accessories, serves as protection for the DWD optics. The photograph (Figure 20) illustrates several of the accessories.

The ESA is used in the following combinations to provide air purging or to create a dead air space zone in front of the Sensor optics to help keep them clean. The combinations also provide shielding from stray radiation emanating from high temperature targets and thermal isolation for the Dirty Window Detector Components. The APA - Air Purge, used in combinations one and two below, provides the best performance. Groupings of accessories are shown in Section 3.10 Accessory

Combinations with Break-out Drawings page 49. Also see Section 3.9.6.1 WJA Water Cooling Requirements page 45.

When using a WJA – Water Jacket Assembly with air cooling, the use of an APA air purge is required with Sensors with the DWD. The use of an APA is also required when viewing large targets over 1000 °C (1832 F).

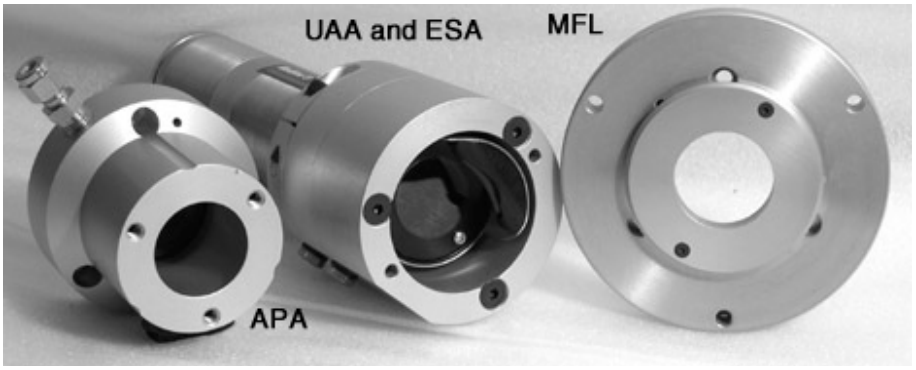


Figure 20: DWD with ESA

1. ESA and APA air purge with clean air provides air purging, and shielding.
2. ESA and APA air purge without air provides a dead air space zone, and shielding.
3. ESA with MFL Flange provides a dead air space zone and shielding.
4. ESA with MFL and AA-3 air purge accessory (not shown) provides air purging and shielding.

See Section 3.12 Other Accessories (Sight Tube, Window, WJ-5 Water Cooling), page 59 for AA-3 references.

3.9 Modline 5 Mounting, Cooling and Air Purging Accessories

3.9.1 UAA – Universal Adapter Accessory Description and Dimensions

The UAA is a circular ring that clamps around the Modline 5 Sensor. A M8 screw tightens the clamp around the Sensor. Three ¼-20 threaded holes on the bottom flat surface allow fastening the UAA to a tripod, user designed mounting surface or the RAM – Right Angle Mounting Bracket.

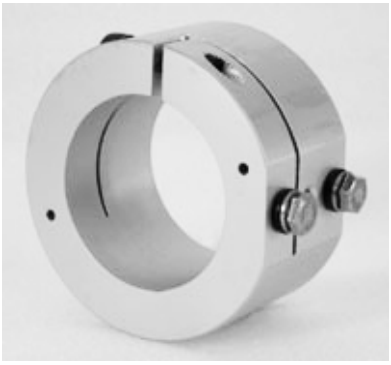


Figure 21: UAA Accessory

Material: Clear Anodized Aluminum
Weight: Approximately 1 Pound (0.5 kg)

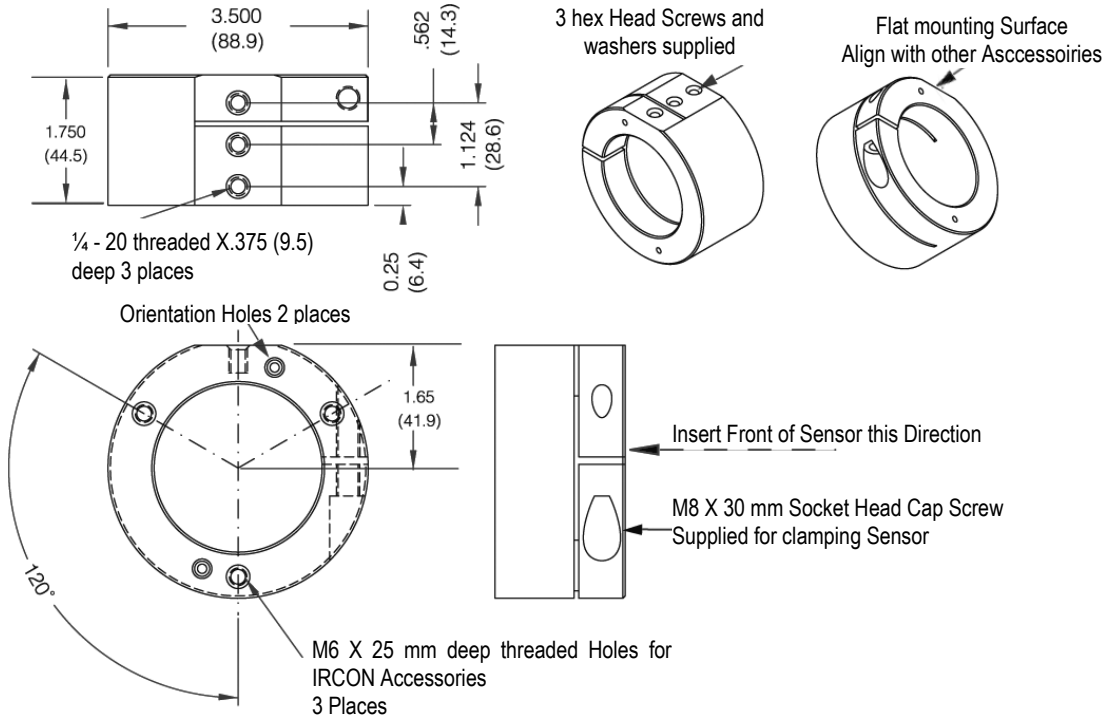


Figure 22: UAA Dimensions

Dimensions are in inches and (millimeters). Do not scale.

Qty	Part No.	Description and use	User Supplied Tools
1	230830C60	M8 X 30 mm socket head caps screw for sensor clamping	6 mm hex key, long arm L style wrench recommended
3	202520540	¼-20 x 5/8 inch (15.9 mm) stainless steel hex head bolt	Adjustable wrench
3	222503200	Stainless steel split ring lock washer	
3	260600060	Black oxide flat washer	

Table 2: UAA Mounting and Assembly Supplied Parts List

3.9.2 RAM – Right Angle Mount Description and Dimensions

The RAM – Right Angle Mount provides convenience, strength and flexibility in mounting the Modline 5 Sensor. The UAA universal adapter is required to attach the Sensor to the RAM. Two holes and one slot on the upright side of the mount are for mounting the Sensor and UAA. Use the slot and outer hole to provide vertical angular adjustment of the Sensor's optical axis. Use the two holes for fixed axis mounting. Two holes and one slot for mounting are located in the base of the RAM. Use the slot and outer hole to provide angular adjustment. Pivoting of the base provides horizontal angular adjustment. Use just the two holes for fixed axis mounting.

Figure 23 RAM Accessory

Material: Passivated Stainless Steel
Weight: Approximately 1.2 pounds (0.55 Kilogram)

Mounting and Assembly Supplied Parts List:

- No hardware is supplied with the RAM. UAA assembly hardware is supplied with the UAA.
- Two user supplied M6 or ¼-20 mounting bolts and washers are required to mount the base of the bracket.

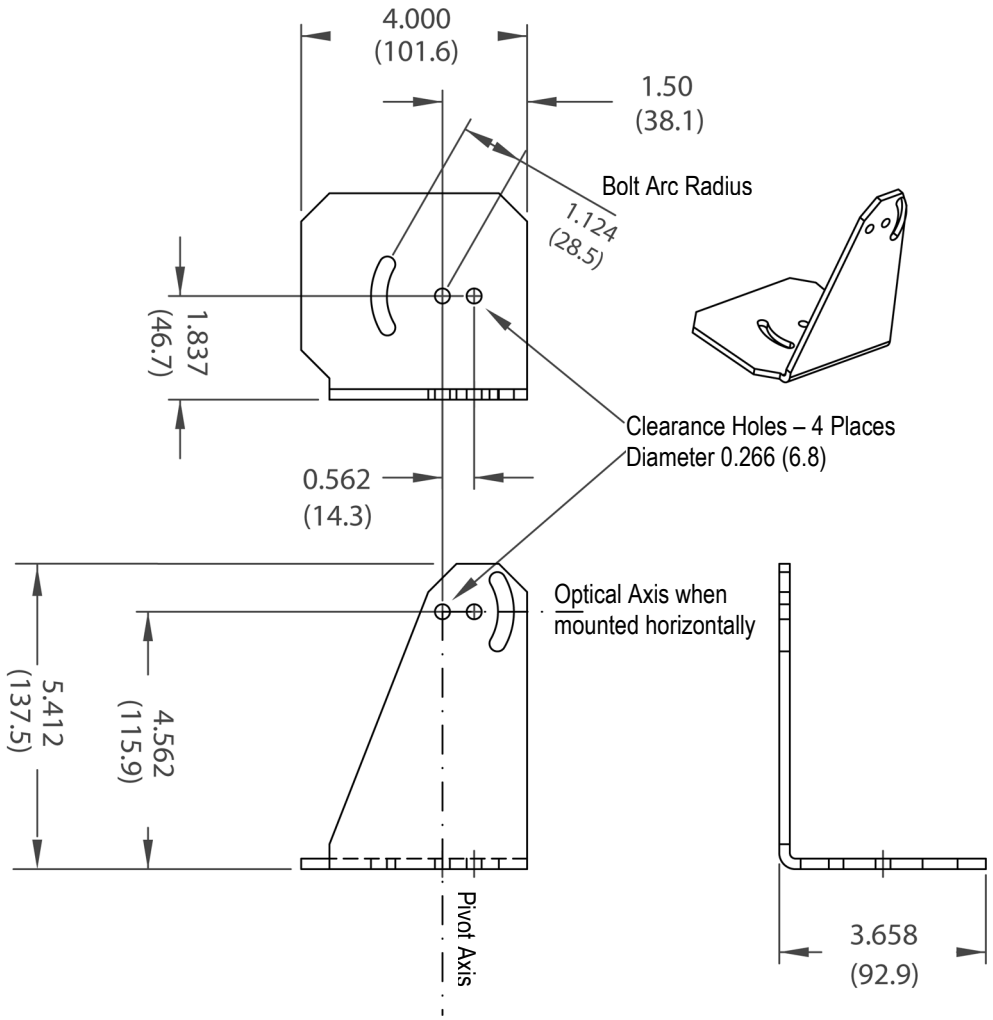


Figure 24: RAM Dimensions

Dimensions are in inches and (millimeters). Do not scale.
All three axis of rotation (including optical axis) intersect at a common point.
This avoids parallax during target alignment

3.9.3 APA – Air Purge Accessory Description and Dimensions

IRCON's specially designed air purge is used to help keep the front optics of the Modline 5 clean. The purge provides a stream of air away from the Sensor to prevent dust and smoke particles from collecting on the optics.

The APA is positioned in front of the Sensor with the UAA universal adapter or WJA Water Jacket. Three through holes in the APA accept mounting hardware to assemble accessories together.

The front of the APA has three threaded holes to attach a MFS or MFL mounting flange. Mounting hardware is supplied with the flanges.

A ¼ inch NPT threaded air inlet is located on the air purge. A flow rate of 3 SCFM (0.09 m3/min.) clean air is required for most applications. The flow rate can be increased for difficult environments.

Two drain holes provide an outlet for any condensation accumulation. If necessary, these threaded holes can be plugged with M3 screws.

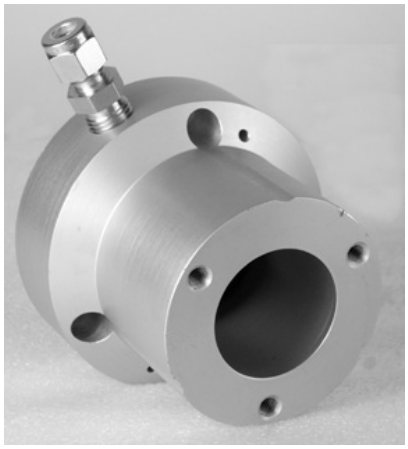


Figure 25: APA Accessory

Material: Clear Anodized Aluminum
Weight: Approximately 1.5 pound (0.68 kilograms)

Qty	Part No.	Description and use	User Supplied Tools
1	482202	¼ inch NPT stainless steel fitting for 0.25 inch (6.4 mm) diameter tubing. Note: Can be replaced with more suitable fitting if desired.	As needed.
3	230625C60	¼- M6 X 25 mm socket head cap screw for assembling to the WJA or UAA.	5 mm hex key L style wrench.
3	230670C60	M6 X 70 mm socket head cap screw for assembling to the WJA or UAA with ESA.	5 mm hex key, long arm L style wrench recommended.

Table 3: Mounting and Assembly Supplied Parts List

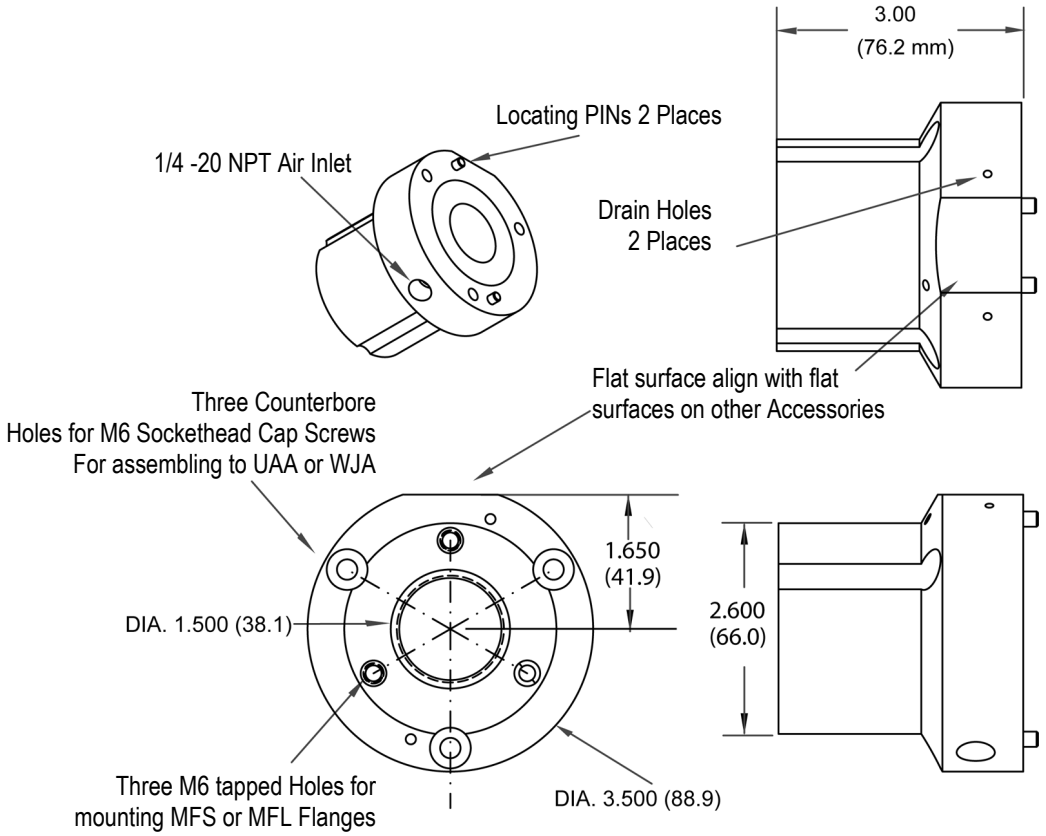


Figure 26: APA Dimensions

Dimensions are in inches and (millimeters). Do not scale.

3.9.4 MFL – Mounting Flange Large Description and Dimensions

The larger of the two mounting flange accessories, the MFL has the bolt circle pattern that matches many of IRCON's other products and accessories. It provides a simple means of replacing older instruments and using existing accessories. See Section 3.12 for Other Accessories.

The MFL is mated to the Sensor by attaching it to the threaded holes in the front of the UAA, APA and WJA accessories. Inner and outer groups of three through holes are used for attachment. These holes are covered by a metal gasket.

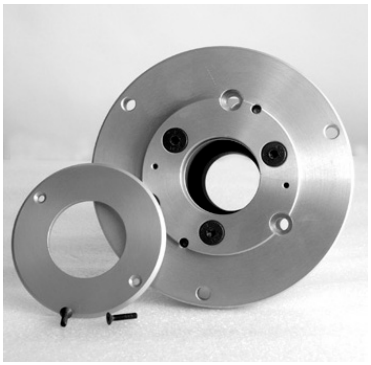


Figure 27: MFL Accessory

Material: Clear Anodized Aluminum
Weight: Approximately 1 pound (0.5 kilograms)

Qty	Part No.	Description and use	User Supplied Tools
1	482172	Metal Gasket Cover	
2	230312C60	M3 X 12 mm flat head cap screw to secure gasket cover	2 mm hex key wrench
3	230630C60	M6 x 30 mm flat head cap screw to assemble the MFL with the APA air purge	5 mm hex key, long arm L style wrench
3	230670C60	M6 x 70 mm socket head cap screw to assemble the MFL to the UAA and ESA extension sleeve. (Not for use with the WJA. Use last item below)	5 mm hex key, long arm L style wrench
3	230620C60	M6 x 20 mm socket head cap screw to assemble the MFL directly to the WJA water jacket or the UAA adapter.	5 mm hex key, long arm L style wrench
3	230665C60	M6 x 65 mm socket head cap screw to assemble the MFL to WJA water jacket with ESA extension sleeve.	5 mm hex key, long arm L style wrench

Table 4: MFL Mounting and Assembly Supplied Parts List

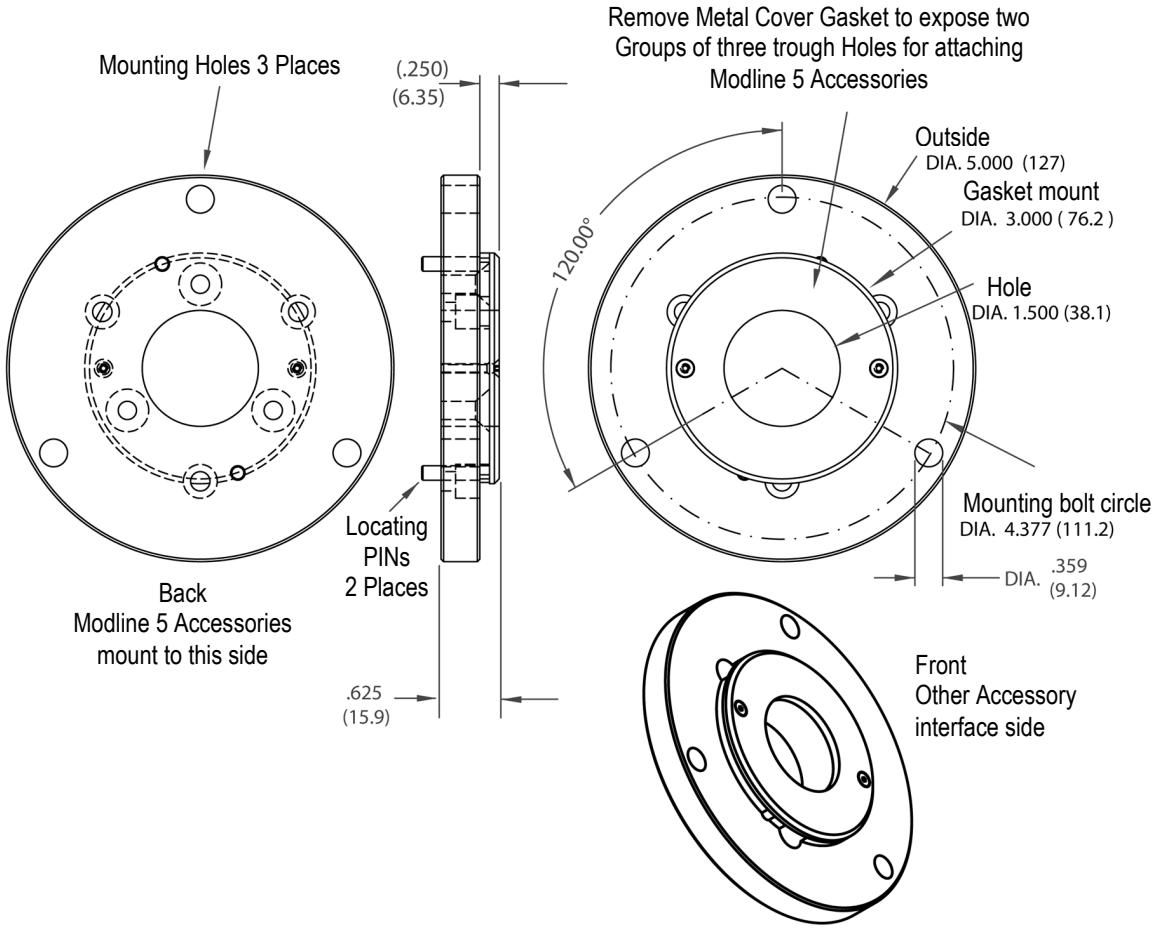


Figure 28: MFL Dimensions

Dimensions are in inches and (millimeters). Do not scale.

3.9.5 MFS – Mounting Flange Small Description and Dimensions

The MFS is a scaled down version of the MFL flange with a smaller diameter bolt circle pattern. This flange provides strength in mounting with a smaller profile. This flange also provides a means of mounting to accessories of other manufacturers.

The MFS is used by first bolting it to the APA air purge. In the photograph is shown the MFS mounted to the APA.

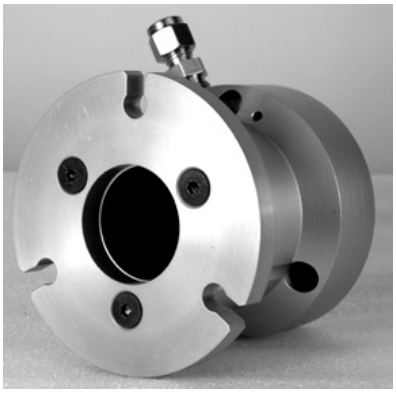


Figure 29: MFS Accessory

Material: Clear Anodized Aluminum
Weight: Approximately 1 Pound (0.5 kilograms)

Qty	Part No.	Description and use	User Supplied Tools
3	230630C60	M6 X 30 mm flat head cap screws to assemble the MFS with the APA air purge	5 mm hex key wrench

Table 5: MFS Mounting and Assembly Supplied Parts List

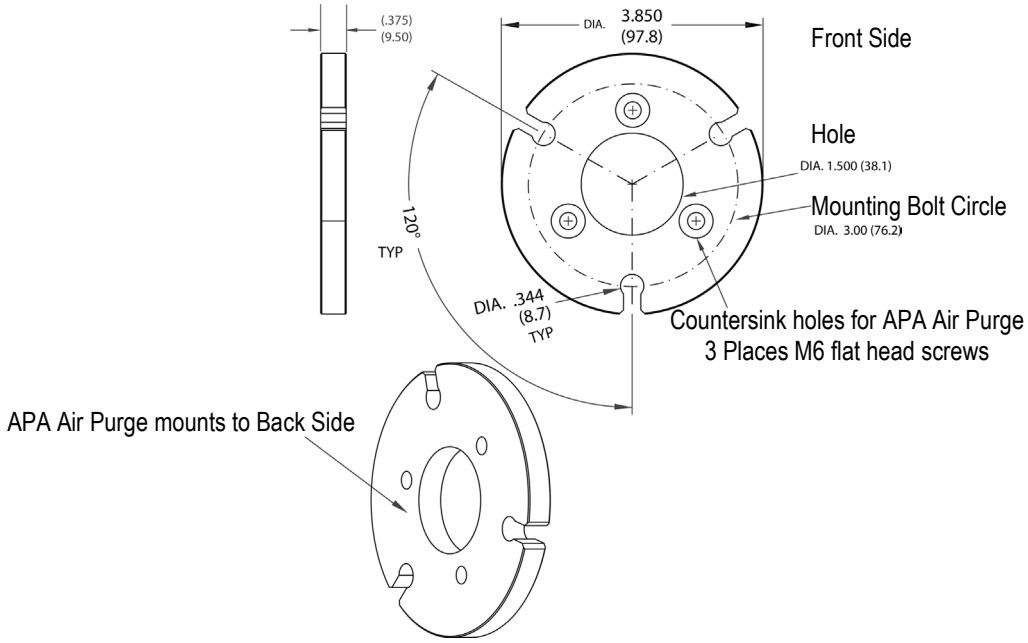


Figure 30: MFS Dimensions

Dimensions are in inches and (millimeters). Do not scale.

3.9.6 WJA – Water Jacket Accessory Description and Dimensions

The WJA uses water or air to cool the Modline 5 Sensor in high ambient temperatures. Water cooling can protect the Sensor in ambient environments up to 200°C (400°F). Air cooling can provide protection to 105°C (220°F).

To properly mount the WJA, the BMA – Base Mounting Bracket, MFL –Mounting Flange, or the APA purge with an MFS or MFL flange should be used. The use of an APA – Air Purge Assembly is recommended with the WJA.

Trunions (pivoting shafts) on the side of the WJA are used to securely mount to the BMA. Threaded holes in the front of the WJA are used to mount an APA air purge or MFL Flange. The WJA can be mounted in any position.

The WJA has 1/4" NPT inlet and outlet pipe fitting openings for water or air. See the drawings and information on the next page for water and cooling air requirements, and installation configurations.

Designed Maximum water or air pressure: 100 PSIG (6.9 BAR)

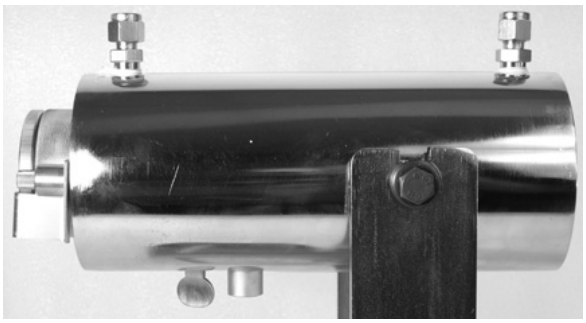


Figure 31: WJA Accessory

Material: 300 series passivated stainless steel
Empty Weight: Approximately 6 pounds (2.7 Kilograms)

Qty	Part No.	Description and use	User Supplied Tools
2	----------	M8 X 16 mm long case hardened steel hex head bolts	Adjustable wrench
2	----------	Extra large diameter 3/16 " thick case hardened flat washers	
2	482202	¼ inch NPT stainless steel fitting for 0.25 inch (6.4 mm) diameter tubing	As needed
1	142152	Safety Clamp Assembly with captive and permanent mount screws	Blade Screwdriver

Table 6: Mounting and Assembly Supplied Parts List

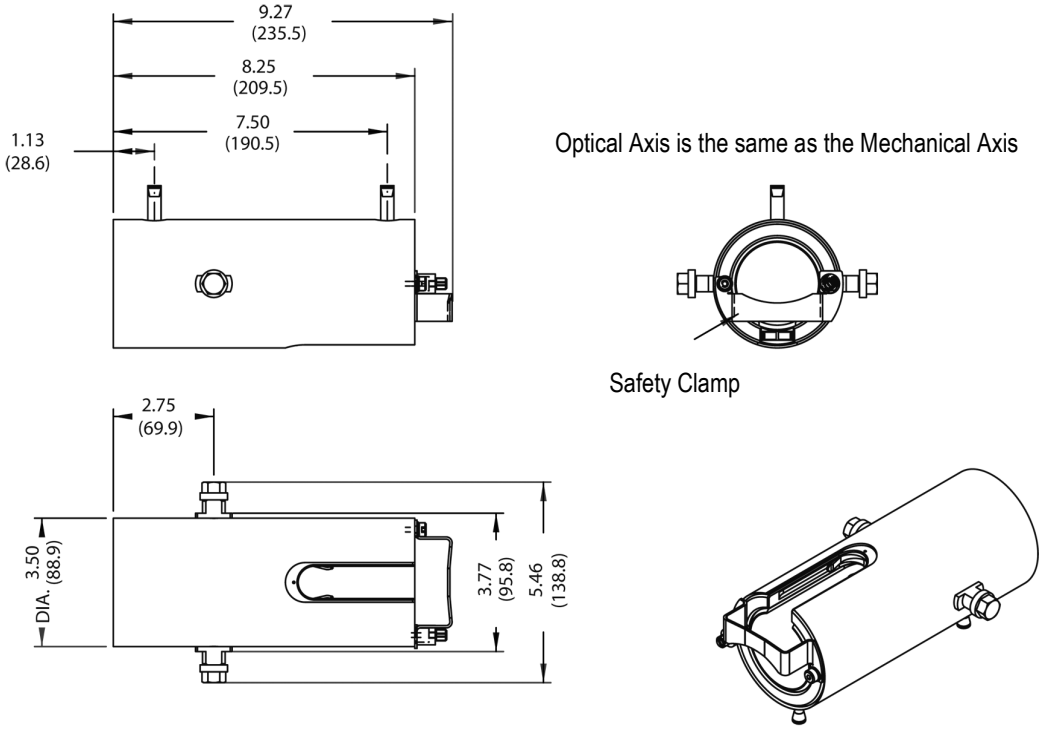


Figure 32: WJA Dimensions

Dimensions are in inches and (millimeters). Do not scale.
Tapped Holes on both ends for Ircon, Inc. Accessories.

3.9.6.1 WJA Water Cooling Requirements

Adequate water flow for a 200°C (400°F) ambient is 15 gallons/hr (57 liters/hr). Cooling water temperature should be 32°C (90°F) or lower. Use the opening closest to the hottest point on the mounted Sensor assembly as the water inlet. Typically this is the opening at the front of the assembly. Use only cooling water compatible with Series 300 stainless steel.

When using water to cool a Sensor with the Dirty Window Detector (DWD), an ESA extension with either a MFL mounting flange or an APA air purge must be part of the assembly. An APA air purge is highly recommended for all installations and must be used when viewing large targets over 1000°C (1832 F). A typical water cooling installation for a Sensor is shown below. APA purge air temperature should be 30°C (86°F) or lower.

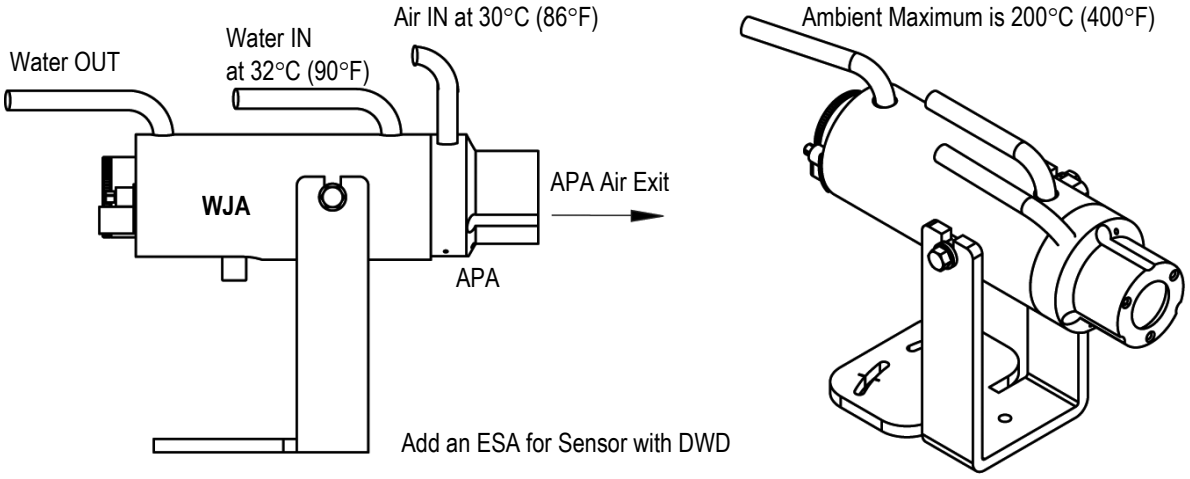


Figure 33: Water Cooling Standard Sensor

3.9.6.2 WJA Air Cooling Requirements.

Adequate cooling air for a 105°C (220°F) ambient is 4 SCFM (114 liters/min). Air temperature should be 30°C (86°F) or lower.

When using air to cool a Sensor with the Dirty Window Detector (DWD), an APA air purge must be part of the assembly and the installation should reflect the drawing below.

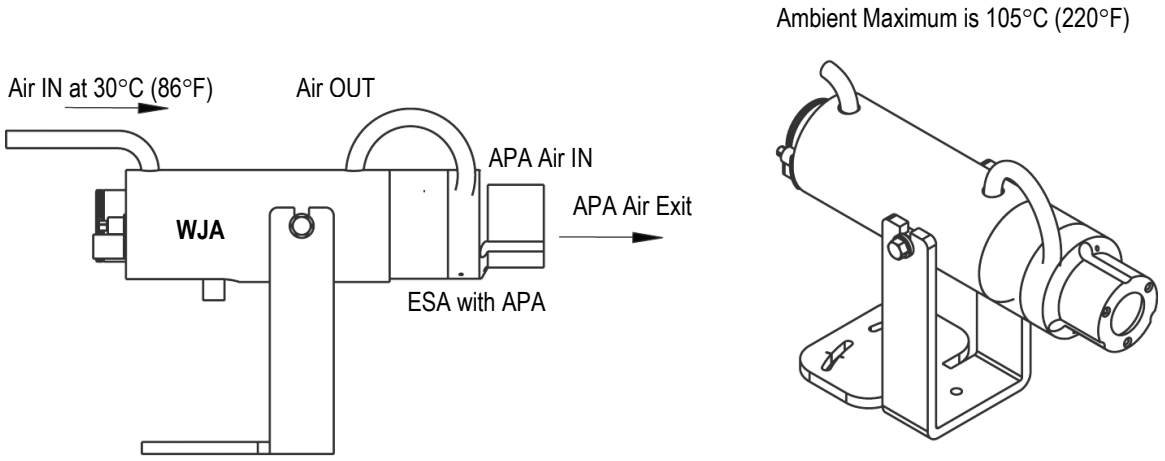


Figure 34: Air Cooling Sensors with DWD

3.9.6.3 Sensor Temperature Alarm

The Modline 5 Sensor provides Alarms when the Sensor's internal temperature exceeds its allowed limit. Error Code X105 signifies the outside influences have caused the internal temperature to rise above its limit. Error Code X103 signifies outside influences have caused the detector to rise above its limit. If these alarms are triggered, check the installation for proper flow of air or water.

Higher than rated ambient temperature can also be the cause. Other possible causes of overheating include radiant and conductive transfer of heat. Insulation, shielding and thermal isolation may be necessary. See Section 8 Applications Guide, page 137 for more information.

3.9.7 BMA – Base Mount Accessory Description and Dimensions

This trunion style U mounting bracket is used as a base mount for the WJA –Water Jacket Accessory. Trunions (pivoting shafts) on the sides of the WJA are placed into the matching BMA mounting slots. The WJA is held in a vertical position, with the Sensor side down, and placed into the slots. The BMA and WJA final assembly can be mounted in any position.

Vertical angular movement of the WJA and Sensor is provided by the pivoting shafts. The BMA mounting slots (gimbals) are shaped to keep the shaft in place and provide secure mounting. Two bolts and two washers are supplied with the WJA to lock it in the final position.

The BMA base mount surface has one clearance hole and two radial slots for mounting bolts. Three M8 or 5/16 inch user supplied bolts and washers are required. Approximately plus and minus 10 degrees of horizontal angular movement is provided to aim the Sensor.

Figure 35: BMA Accessory

Material: Nickel Plated Steel
Weight: Approximately 5.6 pounds (2.5 Kilograms)

Mounting and Assembly Supplied Parts List:

- No hardware is supplied with BMA. UAA assembly hardware is supplied with the UAA.
- Three user supplied M8 or 5/16 mounting bolts and washers are required to mount the base of the bracket.

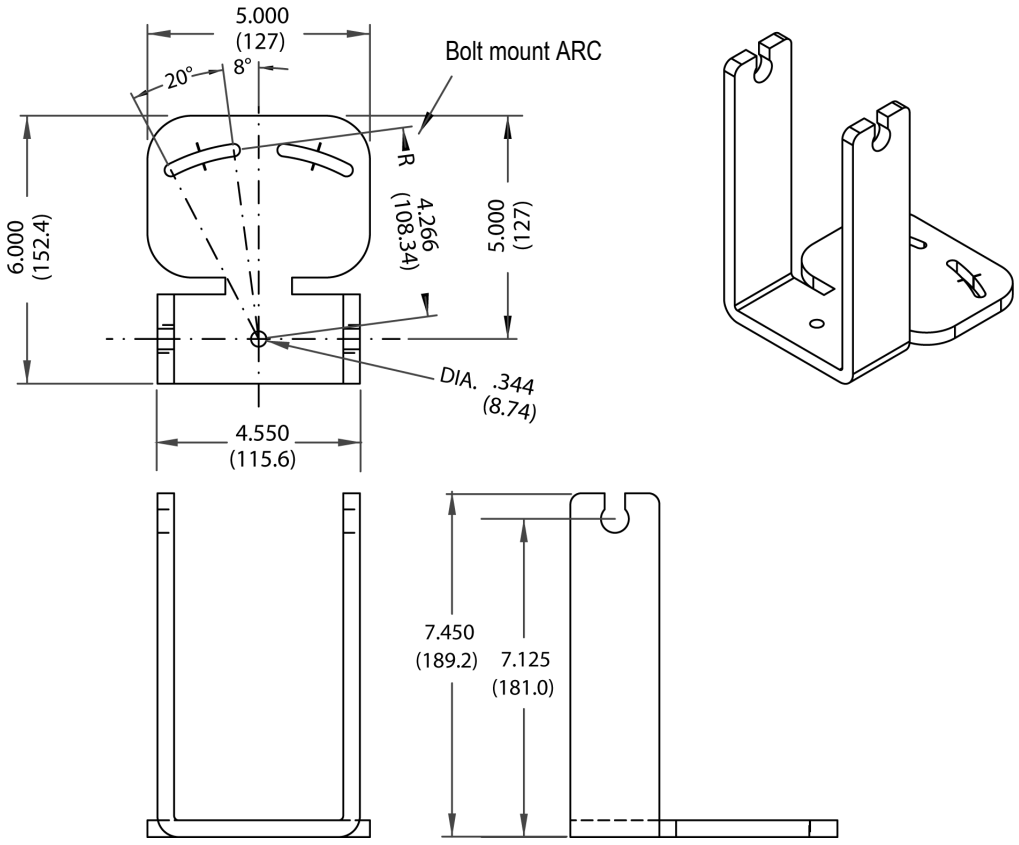


Figure 36: BMA Dimensions

Dimensions are in inches and (millimeters). Do not scale.
Use 5/16 inch or M8 mounting Bolts (3 Places).

3.9.8 ESA – Extension Sleeve Adapter Description and Dimensions

This is a special accessory for Sensors with the Dirty Window Detector (DWD) option. The ESA serves as protection sleeve over the DWD optics and as the mechanical interface between the Sensor and other Modline 5 accessories. The ESA is used in the following combinations to provide air purging or create a dead air space zone in front of the Sensor optics to help keep them clean. The combinations also provide shielding from stray radiation emanating from high temperature targets. The APA air purge, shown in combinations one and two, provides the best performance. The use of an APA is required for large targets over 1000 °C.

1. ESA and APA air purge with clean air (air purging and shielding).
2. ESA and APA air purge without air (dead air space zone and shielding).
3. ESA with MFL Flange (dead air space zone and shielding)
4. ESA with MFL and AA-3 air purge accessory (air purging and shielding).

See Section 3.8 DWD Installation Requirements for DWD and Section 3.12 Other Accessories (Sight Tube, Window, WJ-5 Water Cooling), page 59 for AA-3 references.

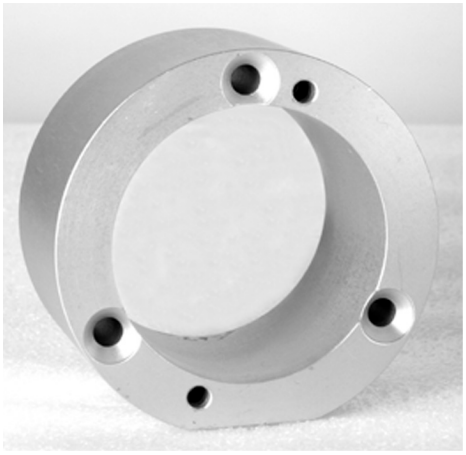


Figure 37

The ESA is also used with the MFL Flange when as an interface with the Right Angle Mounting Bracket.

Material: Clear Anodized Aluminum
Weight: Approximately 1 Pound (0.5 kg)

Mounting and Assembly Supplied Parts List:

- No hardware is supplied with the ESA.
- Assembly screws are supplied with the APA and MFL.

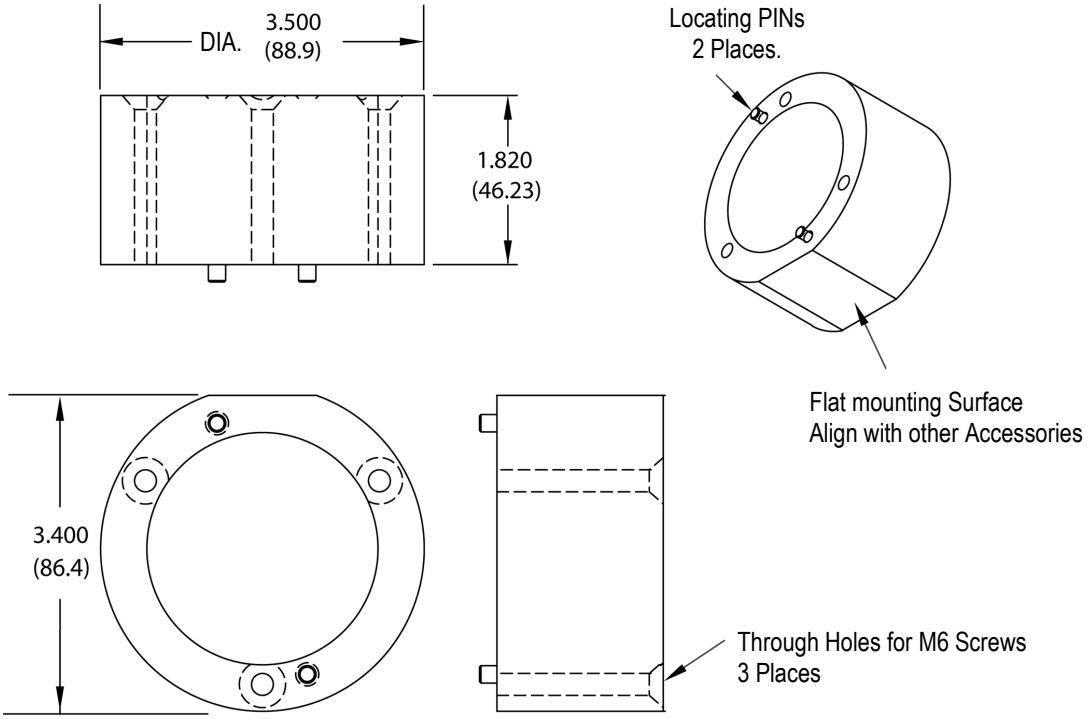


Figure 38: ESA Dimensions

Dimensions are in inches and (millimeters). Do not scale.

3.10 Accessory Combinations with Break-out Drawings

3.10.1 Recommended Accessory Groupings

The table below lists the eighteen recommended accessory groupings. Exploded views of the groups are shown on the following two pages.

The recommended groupings for Sensors with the Dirty Window Detector are identified in the DWD column. See Section 3.8 DWD Installation Requirements, for more information. Groups are illustrated with dimensions in Section 3.11 Installation Drawings and Illustrations.

Group	Mounting Option	Required Accessories							DWD See Notes
1	¼-20 Bolt Pattern Mount	UAA							N. R. (1)
2	Large Flange Interface Mount	UAA						MFL	Add ESA (3)
3	Air Purge with ¼-20 Bolt Pattern Mount	UAA		APA					Add ESA (2)
4	Air Purge with Small Flange Mount	UAA		APA			MFS		Add ESA (2)
5	Air Purge with Large Flange Mount	UAA		APA				MFL	Add ESA (2)
6	Right Angle Base Mount	UAA	RAM						N. R. (1)
7	Right Angle Mount with Air Purge	UAA	RAM	APA					Add ESA (2)
8	Right Angle Mount with Large Flange. This group requires an ESA for clearing the RAM	UAA	RAM					MFL & ESA	ESA Included Note 3
9	Right Angle Mount with Air Purge	UAA	RAM	APA			MFS		Add ESA (2)
10	Right Angle Mount with Air Purge	UAA	RAM	APA				MFL	Add ESA (2)
11	Water Jacket, Air Purge and Small Flange			APA	WJA		MFS		Add ESA (2)
12	Water Jacket with Large Flange Mount				WJA			MFL	Add ESA (3 and 5)
13	Water Jacket, Air Purge and Large Flange			APA	WJA			MFL	Add ESA (2)
14	Water Jacket, Base Mount				WJA	BMA			N. R. (1)
15	Water Jacket, Base Mount, Air Purge			APA	WJA	BMA			Add ESA (2)
16	Water Jacket, Base Mount and Large Flange				WJA	BMA		MFL	Add ESA (3 and 5)
17	Water Jacket, Base Mount, Air Purge and Small Flange			APA	WJA	BMA	MFS		Add ESA (2)
18	Water Jacket, Base Mount, Air Purge and Large Flange			APA	WJA	BMA		MFL	Add ESA (2)

DWD is Dirty Window Detector Option. See ESA on previous page for more information. Also see Sections 3.8 DWD Installation Requirements and 3.9.6 WJA – Water Jacket Accessory Description and Dimensions.

Notes:

1. N. R. = Group Not Recommended for Sensors with DWD.
2. USE the ESA and APA air purge with clean air for air purging and stray radiation shielding. Use APA without air to create a dead air space zone and shielding. The use of an APA is required for large targets over 1000 °C.
3. The ESA with MFL provides dead air space and stray radiation shielding. Add an AA-3 air purge accessory for air purging. See Section 3.12 Other Accessories (Sight Tube, Window, WJ-5 Water Cooling), page 59 for AA-3 information. These combinations not recommended for large targets over 1000 °C.
4. The ESA adds 1.82“ (46.2 mm) to length of the assembled group.
5. Use water for cooling only. Do not use air for cooling with DWD unless the APA air purge accessory is used. See information in Section 3.9.6 WJA – Water Jacket Accessory Description and Dimensions.

Table 7: 3.10.1 Recommended Accessory Groupings

Accessory Illustrations for Groups using UAA:

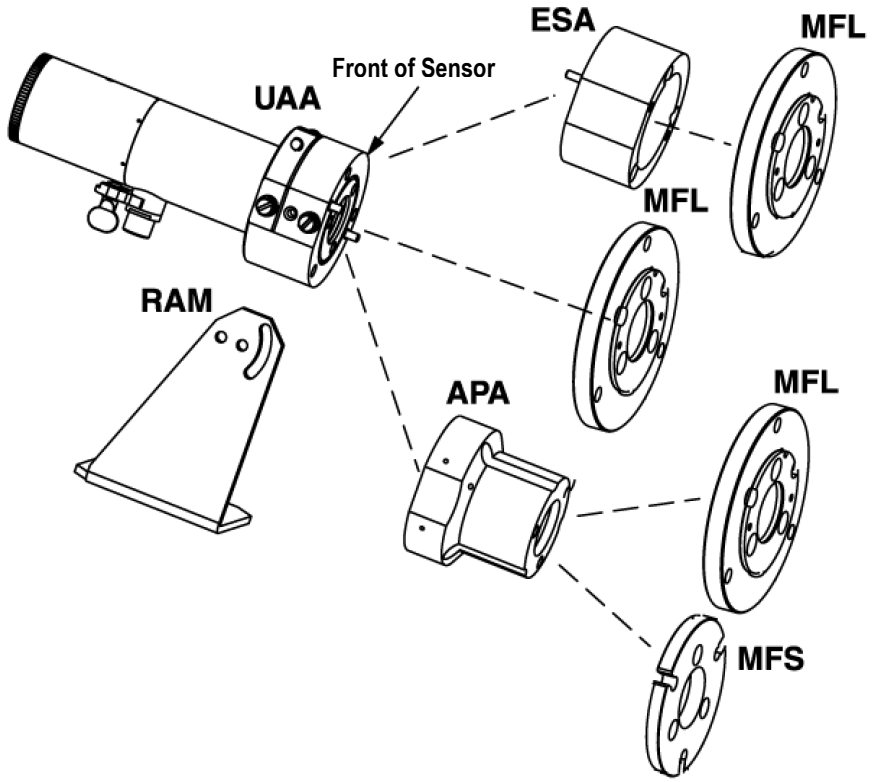


Figure 39: Sensor without DWD – UAA Accessory Groups 1 through 10

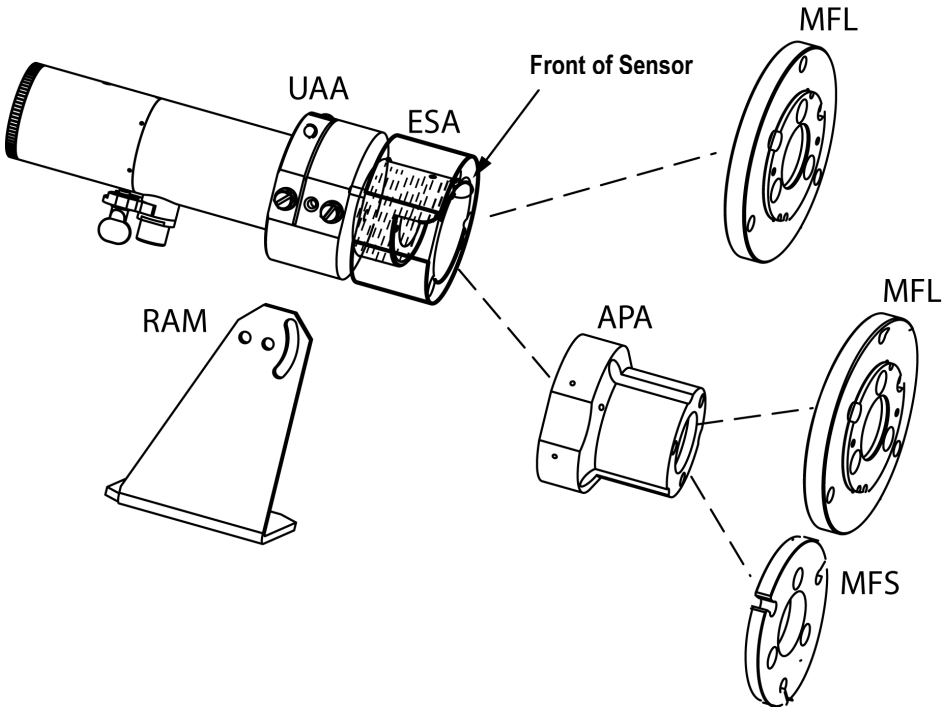


Figure 40: Sensor with DWD – UAA Accessory Groups 2, 3, 4, 5, 6, 7, 8, 9, 10

Accessory Illustrations for Groups using WJA:

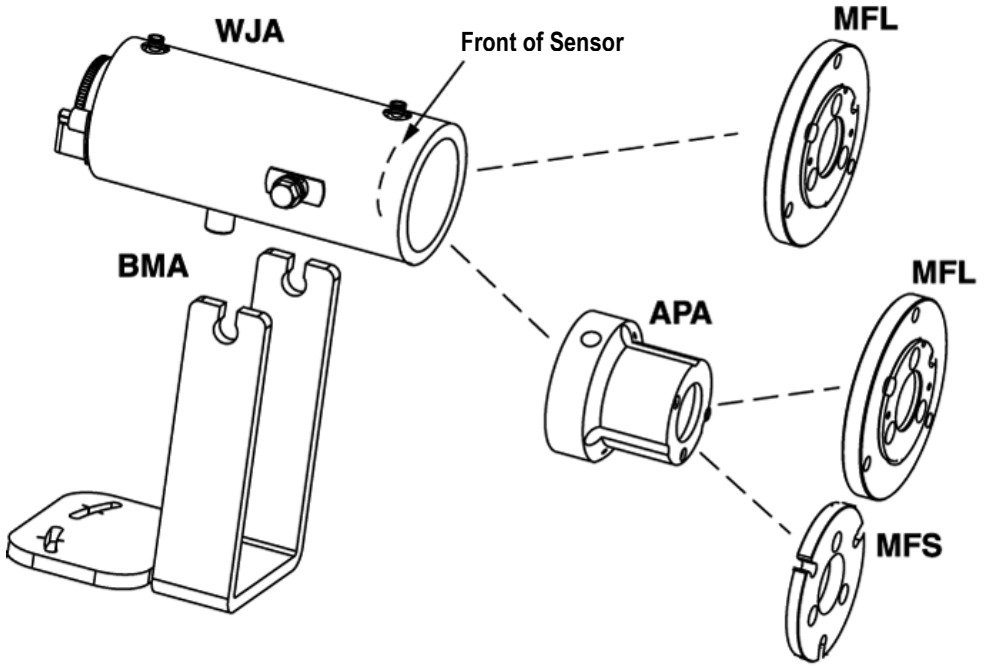


Figure 41: Sensor without DWD – WJA Accessory Groups 11 through 18

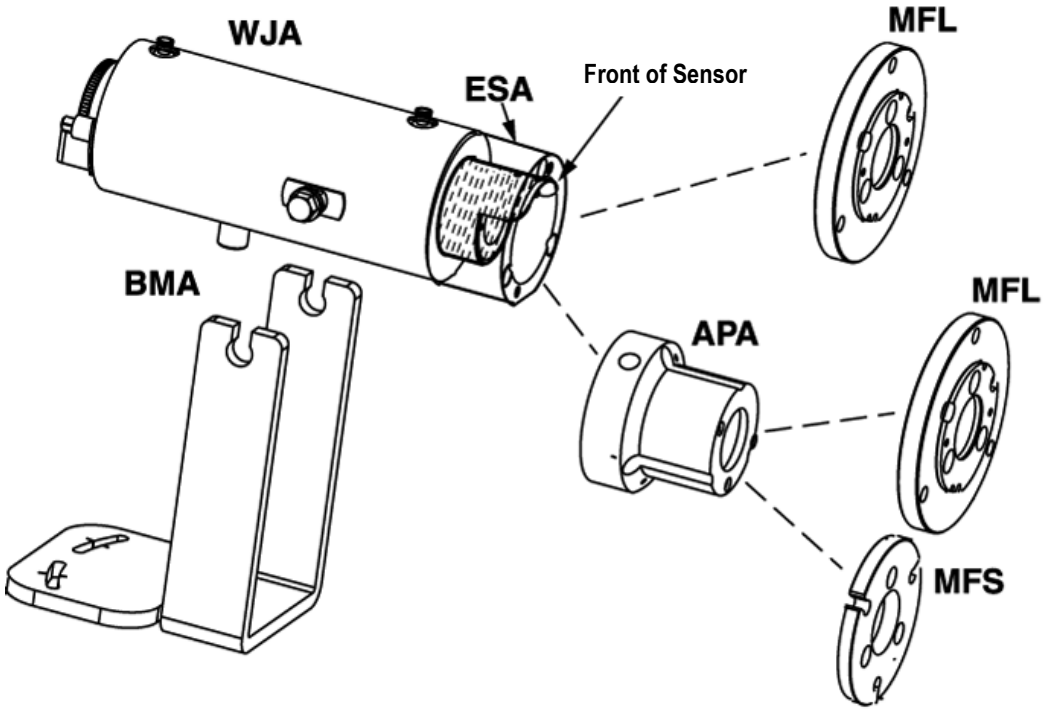


Figure 42: Sensor with DWD – WJA Accessory Groups 11, 12, 13, 15, 16, 17, 18

3.11 Installation Drawings and Illustrations

3.11.1 Installation Drawing for the UAA – Universal Adapter for Tripod or Custom Mounting

Group	Mounting Option	Required Accessories. See Individual Accessory Descriptions and Dimensions.							DWD See Notes
1	¼-20 Bolt Pattern Mount	UAA							N. R.
2	Large Flange Interface Mount	UAA						MFL	Add ESA (3)
3	Air Purge with ¼-20 Bolt Pattern Mount	UAA		APA					Add ESA (2)
4	Air Purge with Small Flange Mount	UAA		APA			MFS		Add ESA (2)
5	Air Purge with Large Flange Mount	UAA		APA				MFL	Add ESA (2)

DWD is Dirty Window Detector Option. Refer to notes with Grouping table in Section 3.10 Accessory Combinations with Break-out Drawings. The ESA adds 1.82 " (46.2 mm) to length of the assembled group.

Table 8: Recommended Accessory Groupings UAA

Figure 43: Front mounted

Figure 44: UAA with APA

When using the MFL (Group 2) or APA (Group 3, 4, 5), assemble these accessories to the UAA first. Place Sensor fully into assembly and rotate Sensor to desired position. Tighten clamping screw.

Sensor front surface will be positioned at the back end of the APA or MFL. To determine working distance (D) for spot size formula d=D/F, measure or calculate from that point.

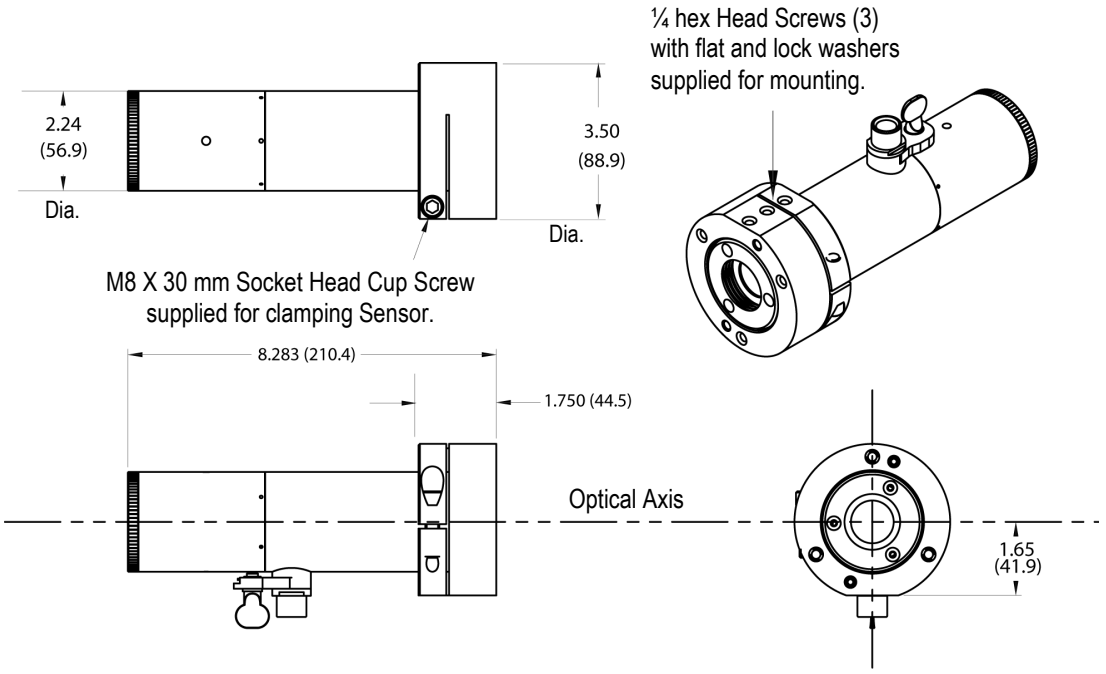


Figure 45: UAA

Dimensions are in inches and (millimeters). Do not scale.
Group 1 shown (UAA and Sensor).
See UAA description and Dimensions.
Sensor Front inserted Level with UAA Front.

3.11.2 Installation Drawing for the RAM – Right Angle Mount

Group	Mounting Option	Required Accessories. See Individual Accessory Descriptions and Dimensions.							DWD See Notes
6	Right Angle Base Mount	UAA	RAM						N. R.
7	Right Angle Mount with Air Purge	UAA	RAM	APA					Add ESA (2)
8	Right Angle Mount with Large Flange. This group requires an ESA for clearing the RAM	UAA	RAM				ESA	MFL	Note 3
8	Right Angle Mount with Large Flange	UAA	RAM					MFL	Add ESA (3)
9	Right Angle Mount with Air Purge	UAA	RAM	APA			MFS		Add ESA (2)
10	Right Angle Mount with Air Purge	UAA	RAM	APA				MFL	Add ESA (2)

DWD is Dirty Window Detector Option. Refer to notes with Grouping table in Section 3.10 Accessory Combinations with Break-out Drawings, page 49. The ESA adds 1.82 " (46.2 mm) to length of the assembled group.

Table 9: Recommended Accessory Groupings RAM

Figure 46

Figure 47

When using the MFL (Group 8) or APA (Group 7, 9, 10), assemble these accessories to the UAA and RAM first. Place Sensor fully into assembly and rotate Sensor to desired position to clear table. Tighten clamping screw.

Sensor front surface will be positioned at the back end of the APA or MFL. To determine working distance (D) for spot size formula d=D/F, measure or calculate from that point.

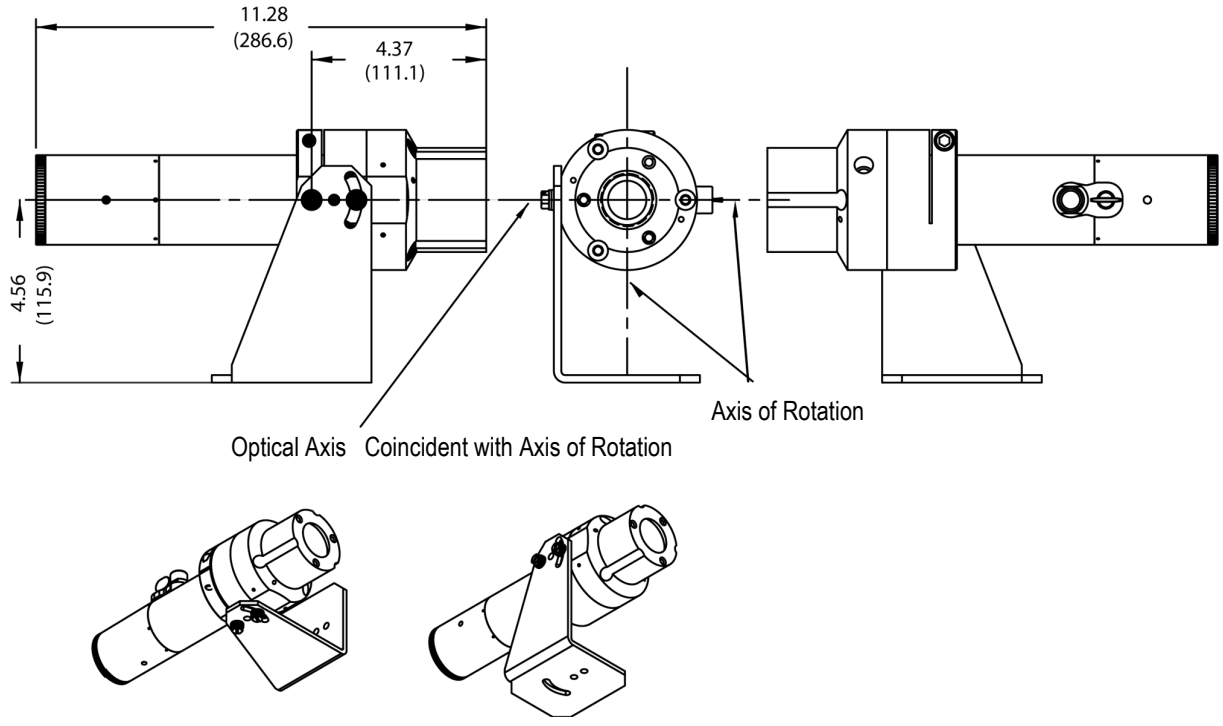


Figure 48: Group 7 shown (UAA RAM and APA).

Dimensions are in inches and (millimeters). Do not scale.
See individual Accessory drawings.

3.11.3 Installation Drawing using the WJA – Water Jacket Accessory with Flange Mounts

Group	Mounting Option	Required Accessories. See Individual Accessory Descriptions and Dimensions.				DWD See Notes
11	Water Jacket, Air Purge and Small Flange	APA	WJA	MFS		Add ESA (2)
12	Water Jacket with Large Flange Mount		WJA		MFL	Add ESA (3)
13	Water Jacket, Air Purge and Large Flange	APA	WJA		MFL	ESA (2)

DWD is Dirty Window Detector Option. Refer to notes with grouping table in Section 3.10 Accessory Combinations with Break-out Drawings, page 49. The ESA adds 1.82 " (46.2 mm) to length of the assembled group.

Table 10: Recommended Accessory Groupings WJA with Flange Mounts

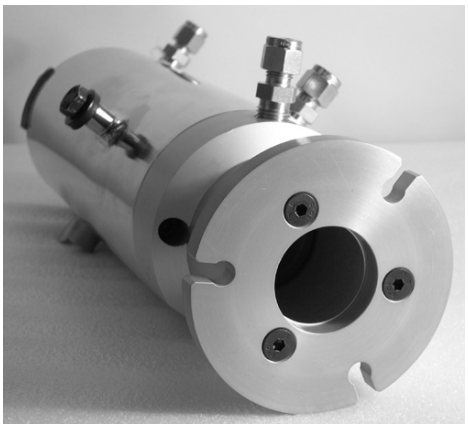


Figure 49WJA with Flange Mounts

Insert Sensor into the WJA assembly with moderate force until it "snaps" into the spring catch. Secure the Sensor rear protection and sighting window. Swing safety clamp into position and tighten.

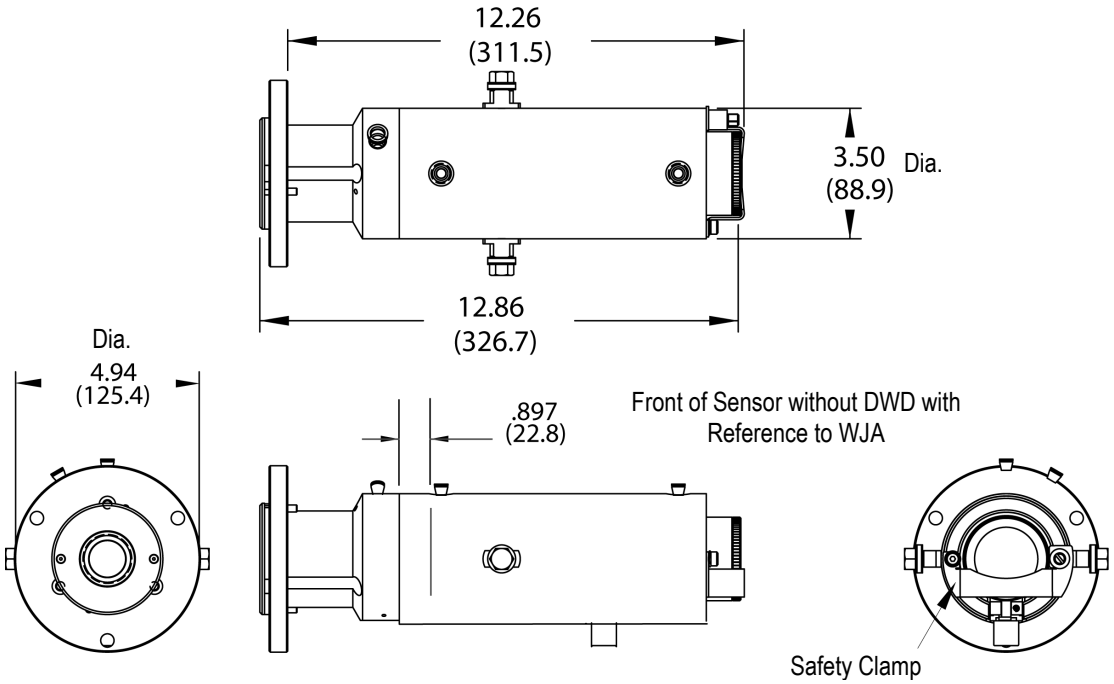


Figure 50: Group 13 shown WJA, APA and MFL Flange

Dimensions are in inches and (millimeters). Do not scale.
Total Lengths Dimension shown with and without MFL Flange.
Mechanical and optical Centerlines are coincidental.

3.11.4 Installation Drawing using the WJA Water Jacket Accessory with the Base Mount Adapter

Group	Mounting Option	Required Accessories. See Individual Accessory Descriptions and Dimensions.				DWD See Notes
14	Water Jacket, Base Mount		WJA	BMA		N. R. (1)
15	Water Jacket, Base Mount, Air Purge	APA	WJA	BMA		Add ESA (2)
16	Water Jacket, Base Mount and Large Flange		WJA	BMA	MFL	Add ESA (3)
17	Water Jacket, Base Mount, Air Purge and Small Flange	APA	WJA	BMA	MFS	Add ESA (2)
18	Water Jacket, Base Mount, Air Purge and Large Flange	APA	WJA	BMA	MFL	Add ESA (2)

DWD is Dirty Window Detector Option. Refer to notes with Grouping table in Section 3.10 Accessory Combinations with Break-out Drawings, page 49. The ESA adds 1.82 " (46.2 mm) to length of the assembled group.

Table 11: Recommended Accessory Groupings WJA with BMA

Figure 51

Insert Sensor into the WJA assembly with moderate force until it "snaps" into the spring catch. Secure the Sensor rear protection and sighting window. Swing safety clamp into position and tighten.

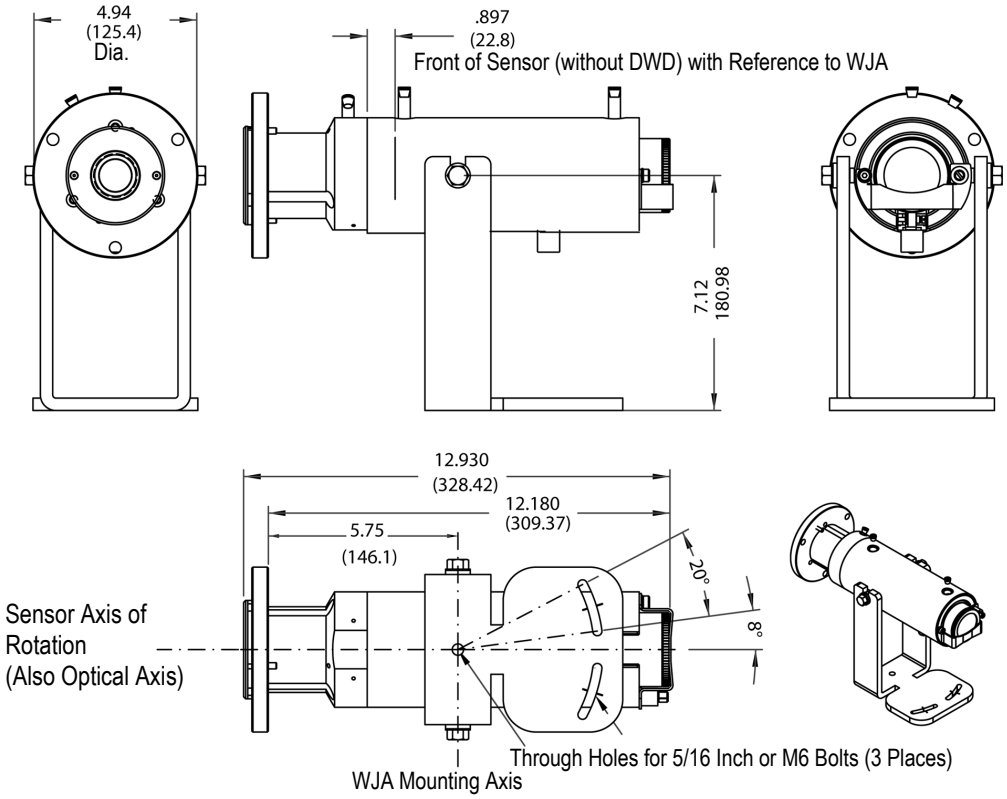


Figure 52: Group 18 shown (BMA, WJA and MFL).

Dimensions are in inches and (millimeters). Do not scale.
See individual Accessory drawings.
Total Lengths Dimension shown with and without MFL Flange.

3.12 Other Accessories (Sight Tube, Window, WJ-5 Water Cooling)

These other accessories are described in Product Bulletin PB-0070. Specification and mounting configuration changes are required for certain items when used with the Modline 5.

Consult the IRCON factory for information about using these accessories with the Modline 5 Sensor.

Other Accessory Model / Part	Compatibility and main interface
AA-3	Requires MFL Flange to interface.
AP-Q, AP-CF	Requires MFL Flange to interface. Consult Ircon, Inc. with application details.
MF-1, MF-2 Threaded collars for threaded 1-1/2 inch NPT sight tubes and 2-1/2 inch NPT sight tube.	Requires the MFL Flange to interface. See note below.
PM-2 Pipe Mounts for use with STSC and STA Sight and Target Tubes	Requires the MFL Flange to interface. See note below.
STM Sight Tubes with Flange Surface	Requires the MFL Flange to interface. See note below..
WA-3 Water Cooling Accessory	Not compatible with Modline 5 Sensors. Do not use to provide cooling.
WJ-5 Water Cooling Jacket with Air Purge.	A mounting kit, UAA, and MFL is required to install Modline 5 Standard Sensor in WJ-5. Maximum ambient temperature limited to 160 °C (320 °F). Note: Not compatible with Modline 5 Sensor with Dirty Window Detector Option (DWD) installed. See installation details below.

Table 12: Compatibility with other Accessories

Focus Sensor with rear rotating focus section. If looking through a sight tube or sight hole, position, align and rotate the Sensor and Sight tube to center the reticle or laser image in the field of view.

3.12.1 M5WJ5 – Mounting Kit

The M5WJ5 Mounting Kit is used with UAA and MFL Mounting Accessories to install a Modline 5 Sensor in an Ircon Model WJ-5 Water Cooling Jacket. The jacket provides cooling through a stainless steel coiled pipe embedded in the jacket walls. A flow rate of 20 gallons per hour (75 liters per hour) of water with a temperature of 90°F (32°C) or less is required.

An air purge is included on the front of the WJ-5. Clean, dry purge air should be provided at a flow rate 6 ft^3/min. (0.7^{3}m/min).

The jacket protects the Modline 5 Sensor in ambient temperatures up to 160°C (320F). Complete specifications, installation and piping instructions are included with the kit. The Modline 5 Sensor cable is rated to 200°C (400F).

The Modline 5 Sensor with the Dirty Window Detector Option (DWD) cannot be installed in a WJ-5 Jacket because of its additional length.

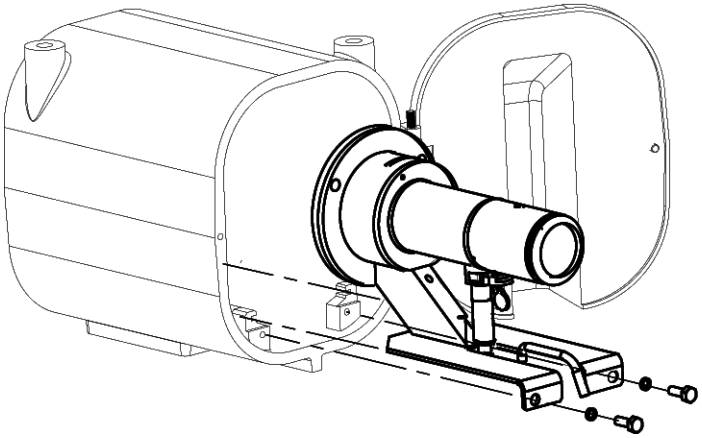


Figure 53: M5WJ5 – Mounting Kit

Accessories and kit required for mounting Modline 5 Sensor in WJ-5 Water Cooling Jacket:

- Model WJ-5 Water Cooling Jacket with Air Purge Supplied with its own mounting hardware (M5WJ5 Kit is not included.)
- UAA Universal Adapter Accessory Supplied with its own mounting hardware
- MFL Mounting Flange Large Accessory Supplied with its own mounting hardware
- M5WJ5 Mounting Parts Kit: Consisting of the following. (Note: These parts are sold only as a kit.)

Item	Qty.	Part Number	Description	Function
1	1	050501	INST: WJ-5 Rev. C	Complete specifications, cautions and installation instructions
2	1	482322	Mod 5 WJ5 Spacer Block	Spacer between UAA and Plate
3	1	456862	Mod 5 WJ5 Mounting Plate	Slides assembly into WJ-5
4	2	202524660	¼-20 X ¾ inch long Socket Head Cap Screw	Mount Spacer Block to UAA
5	4	202524540	¼-20 X ¾ inch long Hex Head Screw	Mounting Plate to Spacer (2) Mounting Plate to WJ-5 (2)
6	4	222503030	1/4 in. Split-ring lock washers	Use with ¼-20 X ¾ inch long Hex Head Screws (4)

Table 13

Assembly and Sighting Instructions:

Refer to Installation Instructions for WJ-5, Included in M5WJ5 Kit

1. Assemble as indicated in drawing to the right and at top of page.
2. Slide assembly into WJ-5 and tighten rear mounting plate screws.
3. Focus Sensor with rear rotating focus section.
4. If looking through a sight tube or sight hole, position, align and rotate the Sensor and Sight tube to center the reticle or laser image in the field of view.
5. Route the cable either through the center opening in the mounting plate or along the side walls of the WJ-5 and out through the insulated opening in the back door.

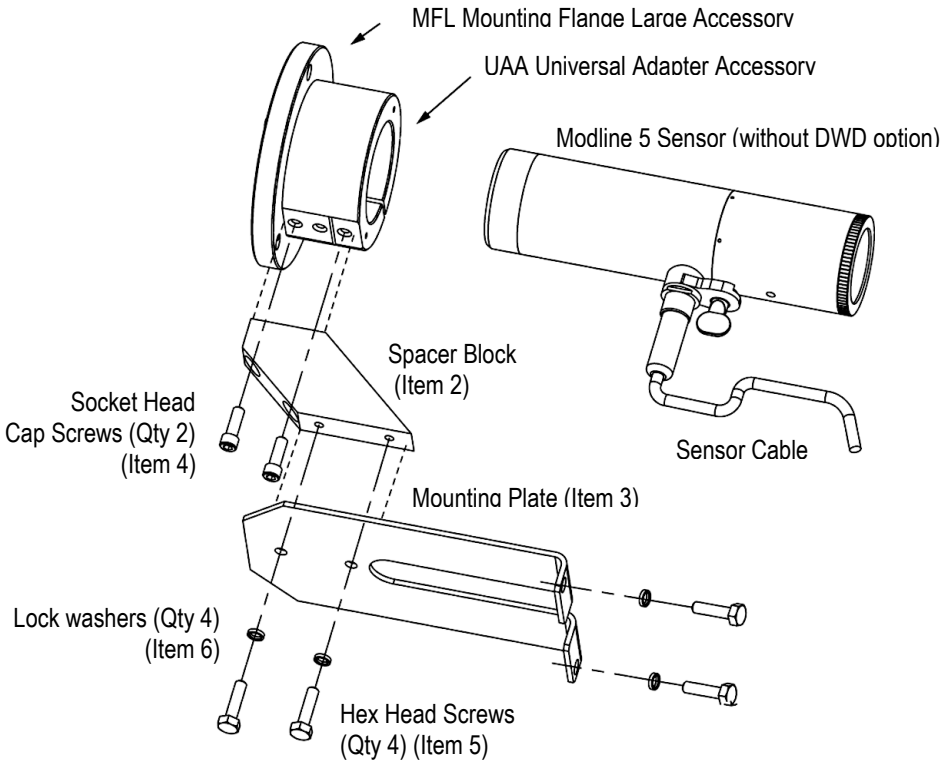


Figure 54: Mounting Kit

3.13 Sensor Installation Checklist

To ensure accurate, reliable, and trouble-free operation, check the installation for the following:

Sensor is properly mounted and aligned with no obstructions in optical path.

Sensor lens is focused on target. If possible, target size is at least twice diameter of reticle size as seen in the viewing sight (i.e. twice the calculated spot size at the viewing distance).

Rear Protective window has been securely installed on back of Sensor. After completing the sighting and focusing routines, screw the protection window back onto the Sensor to maintain the NEMA 4 (IP65) environmental rating.

Sensor lens is protected by air purge and clean purge air if atmosphere is dirty, oily or corrosive. Do not use purge air with oil or water. Use instrument air or filter adequately.

Sensors with the Dirty Window Detector Option require an APA air purge or other protection as explained in Section 3.8 DWD Installation Requirements, page 34. If the purging air quality is poor, use an efficient filter. In worst cases, leave the air purge assembled to the Sensor, but disconnect the air supply.

Sensor is adequately protected by water or air cooling and/or additional insulation if ambient temperature exceeds safe limits.

Sensor is not subjected to direct or reflected radiated heat from oven walls, flames, etc. that cause it to exceed its temperature rating.

The Sensor mounting surface is grounded (Earth Ground). If not, electrically insulate the housing from the mounting surface. See information in Section 4.14 System Grounding and Shielding, page 86.

4 Sensor Wiring

4.1 Modline 5 Components

The basic Modline 5 system consists of either a standard Sensor or Sensor with Dirty Window Detector option, interconnecting cable, a POI Power Supply/Signal Interface Box or Terminal Strip Plate and as possible option, the DPM Digital Panel Meter Interface.

This section provides instructions for connecting these components, except the DPM, to a process system. Section 9 of this manual describes the installation, wiring and operation of the Model DPM Meter with the Sensor's RS-485 Communications.

Figure 55: Modline 5 Components

4.2 Modline 5 Sensor System Interfacing

The following figure shows a block diagram overview for interfacing the Modline 5 into a process monitoring and control system.

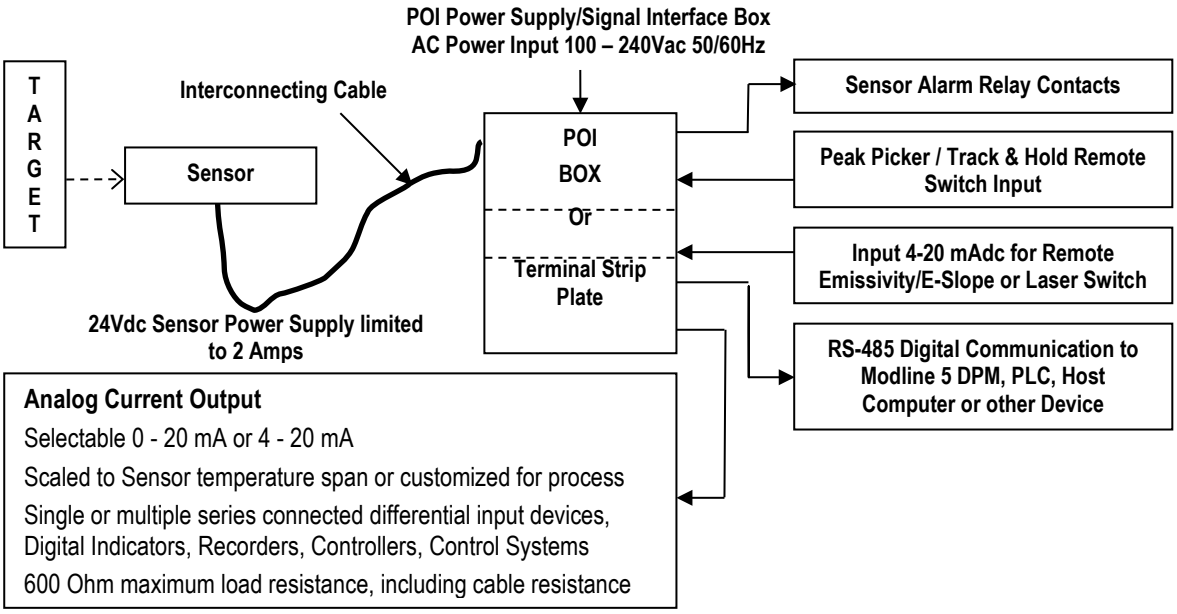

POI Power Supply/Signal Interface Box
AC Power Input 100 – 240Vac 50/60Hz
TARGET
Interconnecting Cable
Sensor
24Vdc Sensor Power Supply limited to 2 Amps
POI
BOX
Or
Terminal Strip Plate
Sensor Alarm Relay Contacts
Peak Picker / Track & Hold Remote Switch Input
Input 4-20 mAdc for Remote Emissivity/E-Slope or Laser Switch
RS-485 Digital Communication to Modline 5 DPM, PLC, Host Computer or other Device
Analog Current Output
Selectable 0 - 20 mA or 4 - 20 mA
Scaled to Sensor temperature span or customized for process
Single or multiple series connected differential input devices, Digital Indicators, Recorders, Controllers, Control Systems
600 Ohm maximum load resistance, including cable resistance

Figure 56: Block diagram

4.3 Modline 5 Sensor Cable

4.3.1 Sensor Interconnecting Cable

The Interconnecting cable carries all inputs, outputs and the 24 VDC power for the Sensor. The cable is routed from the Sensor to the Model POI Power Supply/Signal Interface Box or the Terminal Strip Plate supplied with each cable.

All IRCON Modline 5 interconnecting cables are supplied assembled with the Sensor connector on one end and the wires stripped, tinned and ready for termination on the opposite end. The cable shield is also prepared and ready to assemble with the Ircon supplied EMI shielding strain reliefs. All cable wires are 24 AWG (0.25 mm²), except the 24 V power supply wires that are 22 AWG (0.35 mm²).

Maximum Cable Temperature	Cable temperature not to exceed 200°C (392°F).
Maximum Cable Length	350 feet (107 meters), Minimum Bend Radius 3 inches (76 mm).
Cable Diameter	Nominal Diameter 0.310 inch (7.6 mm).
Cable Routing	Within conduit or low-level signal plenum or cable tray.
Location	Away from high power and high frequency sources and high temperature sources.

Consider the cable route. The cable should be protected from plant traffic and any hostile environments. Avoid high temperature zones or areas subject to electrical or high frequency interference.

4.4 Model POI Power Supply/Signal Interface Box

A POI Power Supply/Signal Interface Box with cover removed and with full a set of Grounding Strain Relief fittings installed is shown below. The box is sent with protective NEMA 4 seals inserted in all cable and conduit entry holes. The strain relief fittings are used to ground the cable shield and are supplied with the box.

Figure 57: POI Power Supply / Signal Interface Box

The POI Box contains a DC power supply that develops 24V for the Sensor Power. The POI accessory also contains a terminal strip for connecting the Sensor cable to user supplied interface cables. Sensor inputs and outputs are interfaced to the user's system at this point.

POI Box Specifications:

Maximum Ambient Temperature	Ambient temperature should not to exceed 55°C (131°F)
Environmental rating	NEMA 4 (IP65)

A three wire AC power cable or individual discrete wires may be used. A 0.83 inch (21.1 mm) conduit entrance is provided for AC power wiring entry. Conduit or a suitable strain relief is required.

Four cable grip strain reliefs are supplied. One is for the Sensor interconnecting cable entry and two are for user-supplied cables that connect to process system devices. These three NEMA 4 (IP65) compliant devices provide electromagnetic interference (EMI) shielding. The fourth is a plastic strain relief for a power cable.

To maintain the NEMA 4 (IP65) rating, the four cable grip strain reliefs supplied and properly sized cables must be installed in the box entrance holes. Do not leave a hole empty. Use a properly sized hole seal that is NEMA 4 (IP65) rated. The hole covers shipped with the box are for shipping purposes only and are not rated.

4.4.1 Mounting the POI Box

Figure 58 includes the mounting dimensions and cable entry locations of the POI Box. Locate to allow clearance for cable entry and cable fittings. Mounting is by means of four user supplied #6 (or metric equivalent) pan head sheet metal or machine screws at the four corners of the main part of the box. When you have selected your mounting location, remove the cover. Mark the hole positions for the mounting screws on the panel or mounting surface you have selected. Drill the mounting holes and attach the box to the mounting surface.

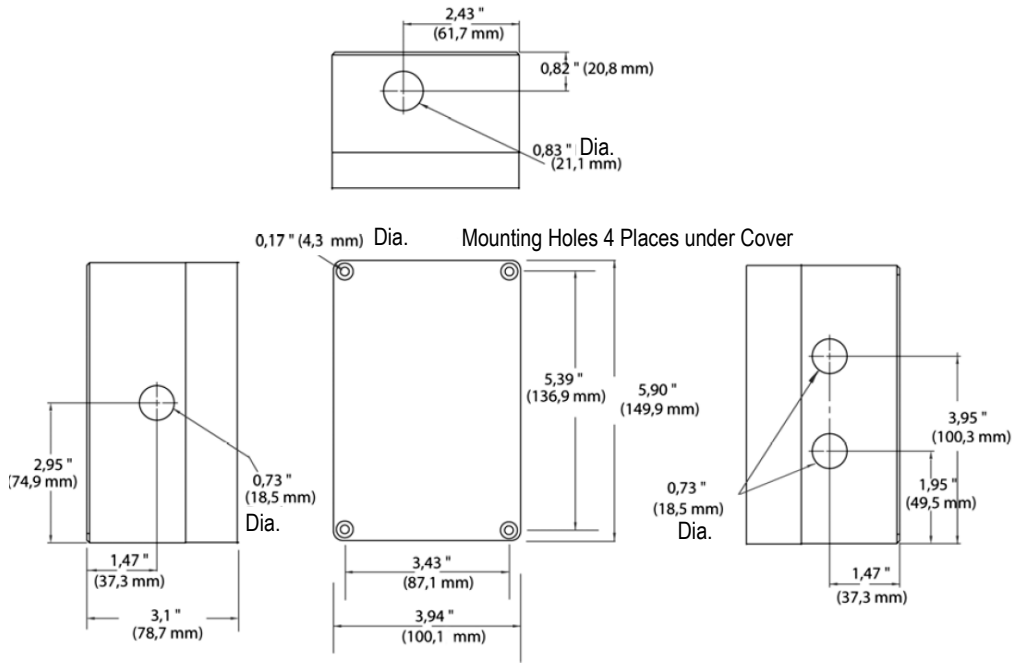


Figure 58: POI Box Dimensions

4.4.2 AC Power and Earth Ground Connections

The POI Box does not include a power switch. You must supply a two-pole switch for 100VAC to 240 VAC at 50 to 60 Hz. The power consumption of the unit is 40 VA maximum. The switch should be clearly marked as the power shutoff for the equipment, visible, and accessible to the operator.

The AC Power Requirement for the Model POI Power Supply/Signal Interface Box is shown below.

AC Power Input Requirements	
Nominal – Continuous	100 to 240 V; 0.3 A; 50/60 Hz
Typical Inrush Current	20 A at 100 VAC, 40 A at 200 VAC

The typical inrush current occurs over a few cycles when power is first applied to the box. The AC supply should be from a separate branch circuit with appropriate circuit breakers. Consideration should be given to the wire size used, the continuous nominal current rating and typical inrush current.

A "clean" power line such as instrument power line is essential. Avoid power lines serving "noisy" electrical equipment. The ideal solution is to power from a separate ac line, independent of all interference producing equipment. If this is not practical, consider using a line conditioner. If you use a line conditioner, connect per the manufacturer's instructions.

Improper installation can result in serious injury or death to personnel! The Modline 5 Sensor and POI Power Supply were designed to meet EN 61010-1: Safety Requirements for Electrical Equipment for Measurement. The installation should be performed as directed in this manual and following any local electrical codes.

Compliance with EN61010-1: Safety Requirements for Electrical Equipment for Measurement requires the installation meet the following alternating current supply and earth grounding requirements.

The installation should be compliant with requirements for a Category II installation.

A three-wire ac supply with a third-wire earth ground, or a separate earth ground wire is required.

Power cables and wires should meet recognized European and American standards for Main Voltage Safety with insulation suitable for single fault condition (600V, 105°C).

Strain relief and compression fittings for the power cable must comply with European and American standards as dictated by the power cable selected.

The wire size for the L and N ac power connections should be no larger than 18 AWG (1 mm²). These power wires cannot be larger in diameter than the ground wire.

Ground wire must be the same size or larger than AC power wires. 18 AWG (1 mm²) is recommended.

A two-pole power shutoff or safety switch should be incorporated within the main power line that powers the IRCON equipment. This switch should be in close proximity to the operator. The switch should be clearly marked as the power shutoff for the equipment.

A properly sized circuit breaker is required in the ac supply lines connecting power

to the Power Supply.

The two-pole switch (and all circuit breakers) should comply with IEC 947 standard. Switches and circuit breakers that carry the markings of TUV, VDE or other European Agencies do meet the IEC 947 standard.

Observe all Local Electrical Codes related to connecting ac power and the grounding of electrical equipment.

4.4.3 Connecting the AC Power and Ground Wires

Use tinned stranded 18 AWG (1 mm²) wire for all AC power and ground connections. Strip insulation from wires 1/4 inch (8 mm).

To access the power wiring and ground terminals, carefully unscrew (start each screw before removing any single screw) the four captive screws that attach the aluminum bracket with the terminal strip and wiring label. Remove the bracket away from the box. Refer to illustration below. Leave the Red and Red/White wires found in the box disconnected at one end until the aluminum bracket is installed after power wiring is performed. Wiring instructions will follow.

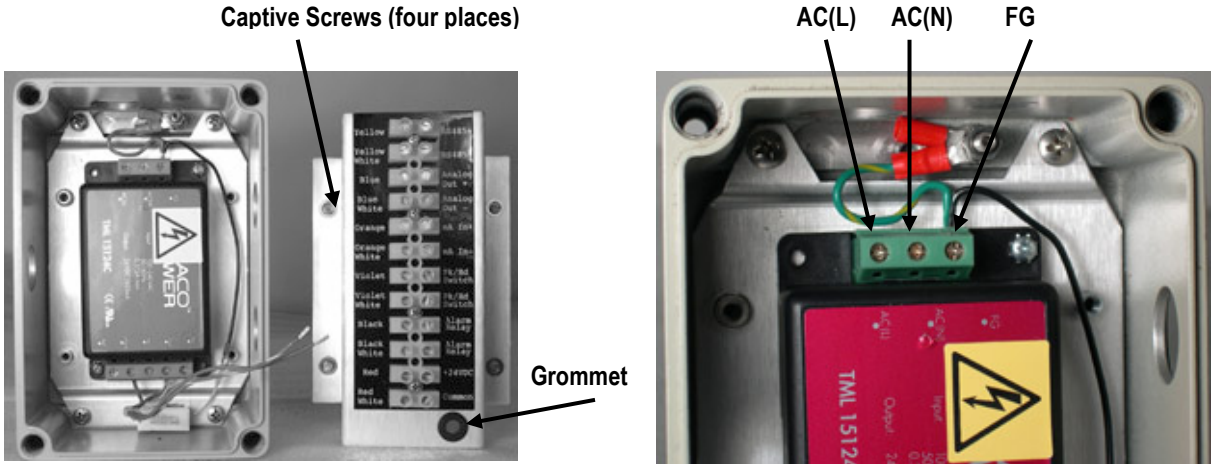


Figure 59: AC Power Wiring Detail

Connect the LINE and NEUTRAL wires of the AC power line to the Power Supply module inside the POI Box. Observe the "polarity" of these connections, LINE to AC(L) and NEUTRAL to AC(N), as indicated on the power supply module. The Power supply module FG connection is pre-wired at the factory. Do not remove this wire.

You must provide an Earth Ground by connecting a ground wire to the threaded grounding stud in the POI Box **exactly** as shown in the Ground Wire Detail Drawing and Photo illustration shown below in Figure 60. Disassemble the ground stud assembly, double crimp the earth ground wire to Item 5. Reassemble the stud assembly exactly as shown below. Make sure all hardware is tightly fastened in each step of the reassembly.

All parts supplied assembled in box (Figure 60).

Item 1: Threaded Ground Stud, M4 X 0.7
Item 2: Quantity 3, Hex Nut M4 X 0.7
Item 3: Quantity 3, Washer M4 External Star
Item 4: Terminal, Number 8 Ring, 16 -22 AWG (0.35 – 1,5 mm²) with internal 18 AWG (1 mm²) stranded Green/Yellow wire attached
Item 5: Terminal Lug, Number 8 Ring LUG, 16 -22 AWG (0.35 – 1,5 mm²)

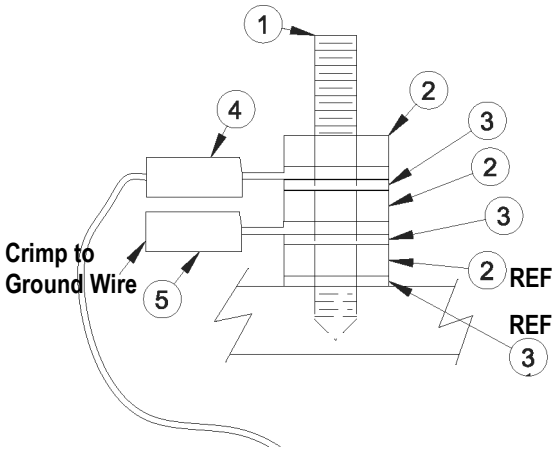


Figure 60: Ground Wire Detail

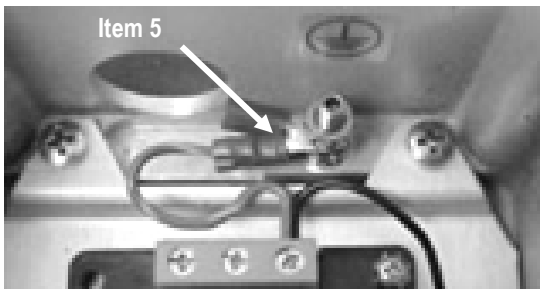


Figure 61: Earth Ground Connection

A qualified electrician should inspect the AC wiring and Ground connections. The complete installation should be reviewed to insure that all switches, circuit breakers and other components have been properly selected and installed.

4.4.4 Connect the 24 VDC Power Supply Wires

Bring the Red and Red/White power wires through the grommet at the bottom of the terminal strip aluminum bracket. Dress the wires so they will not be pinched by the bracket. Re-install the bracket by carefully attaching and securely tightening the four retaining screws. Be sure not to cross thread or otherwise damage any screws. Start each screw before tightening any single screw. Connect the Red wire to the +24VDC terminal and Red/White wire to the Common terminal on the right side of the terminal strip.

A qualified electrician/technician should apply power to the box and measure 24 VDC, +/– 5%, at the Red and Red/White power supply connections on the left side of the terminal strip.

Disconnect AC power at the installed power switch and prepare for connecting the Sensor interconnecting cable and system device cables as explained later in this section.

4.5 TSP Terminal Strip Plate

The TSP is required when the POI Power Supply/Signal Interface Box is not used. This plate mounted terminal strip with terminal identification label and suppression components allows use of the Modline 5 Sensor and Cable with user-supplied enclosures and power supplies. The TSP ensures Sensor and cable operation meets RF emission and immunity standards required for CE certification.

24Vdc Power Requirements
Regulated DC Voltage: 24V +/– 5%
Power Rating: 8 Watts Maximum
Required Current Per Sensor: 380 mA.

The 24Vdc Sensor Power Supply should be limited to 2 Amps.

An earth ground wire is to be connected to the ground stud at the bottom of the Terminal Plate. Minimum size wire is 18 AWG (1 mm²). A crimp terminal is supplied to mount on the stud.

4.5.1 Dimensions and Installation

The Terminal Plate **must** be installed in a suitable user-supplied grounded enclosure for protection from electrostatic discharge (ESD).

Four 0.196 inch (5mm) diameter holes are used to mount the plate. See photo below for mounting dimensions.

The approximate overall rectangular plate dimensions are 5.39 inches (136.9 mm) long by 3.42 inches (86.9 mm) wide and 0.8 inches (20.3 mm) high.

Plan access for cables and working space. Minimum Sensor interconnecting cable bend is 3 inches (76 mm).

Wiring, grounding and shielding instructions are in the sections that follow.

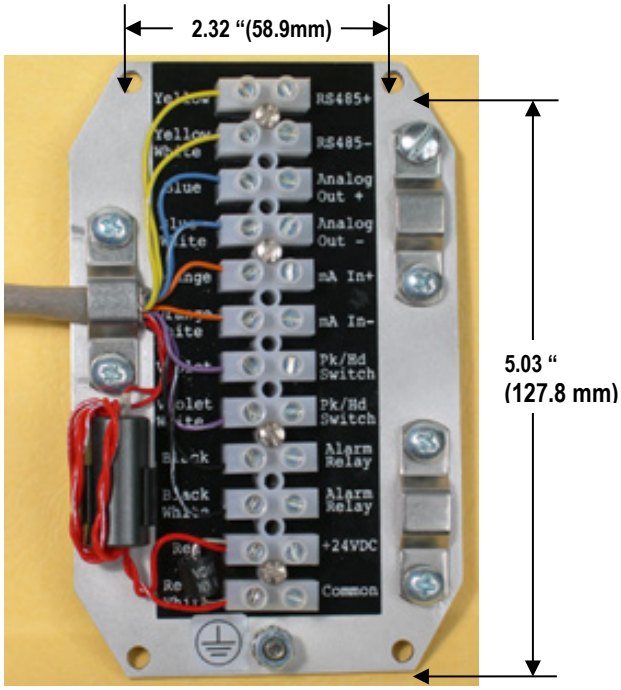


Figure 62: Dimensions TSP

4.6 Sensor Interconnecting Cable Preparation

4.6.1 Cable Preparation

It is very important that the cable shield be properly prepared and installed. All signal cable shielding must be grounded to the POI Box enclosure with the IRCON supplied Grounding Strain Reliefs. If the Terminal Strip Plate is used, the shielding must be clamped to the ground shield clamps on the plate.

All cables must be properly dressed for shield grounding. Twisted pair wires must remain twisted and kept as short as possible. The IRCON Sensor cable is supplied with the connector attached on one end. The opposite wiring end is prepared and supplied as per the following procedure. If the cable is shortened, the preparation procedure must be followed. User supplied cables require similar preparation.

A. Strip off 9 inches (229 mm) of the outer jacket.

B. Partially cut back the outer braided shield. Leave 1 inch (26 mm) of shield exposed to attach a strain relief or connection to a Terminal Strip Plate shield clamp.

C. Cut wires to lengths shown in table below. Note different Red and Red/White wire lengths for POI Box and Terminal Strip Plate. Strip all wire pairs ends 3/8 inch (10 mm) and tin with solder.

Pair	3.5 inches (89 mm)	3.25 inches (83 mm)	3.00 inches (77 mm)	2.50 inches (64 mm)	2.25 inches (57 mm)	1.75 inches (45 mm)
Yellow and Yellow White	Yellow	Yellow White				
Blue and Blue/White			Blue	Blue/White		
Orange and Orange/White					Orange	Orange/White
Violet and Violet/White					Violet/White	Violet
Black and Black/White			Black/White	Black		

Table 14

Red and Red/White wire lengths for POI Box and Terminal Strip Plate:

Red for POI Box	3.25 inches (83 mm)
Red/White for POI Box	3.5 inches (89 mm)
Red for Terminal Strip Plate	10 inches (241.3 mm)
Red/White for Terminal Strip Plate	10 inches (241.3 mm)

D. Select Next Step. If the preparation is for a POI Box, go to sub section Grounding Strain Relief Fitting Assembly on next page. If the preparation is for a Terminal Strip Plate, pull back and comb out the exposed shield. Preparation is now complete. Route and install the interconnecting cable. Refer to Section 4.8 Terminal Strip Plate – Sensor Interconnecting Cable Installation, page 72.

4.6.2 Interconnecting Cable Assembly Continuity Check

If desired, a continuity check of the cable can be made. The table below identifies the receptacle pin and the color coded wire connected to the pin. The illustration below identifies the pin locations on the cable plug end.

Cable Shield is connected to the plug shell.

Pin 1 Black/White
Pin 2 Red
Pin 3 Black
Pin 4 Violet
Pin 5 Blue
Pin 6 Yellow/White
Pin 7 Blue/White
Pin 8 Red/White and Violet/White
Pin 9 Orange
Pin 10 Yellow
Pin 11 Orange/White

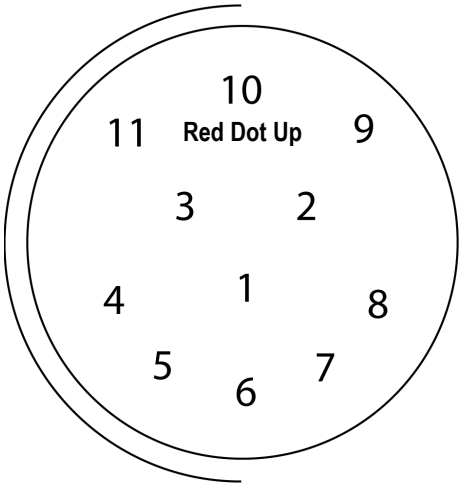


Figure 63

4.6.3 Grounding Strain Relief Fitting Assembly

Inspect the three metal grounding cable strain reliefs supplied with the POI Box. Identify the cable seal. The cable seal is seen from the compression nut side of the fitting assembly. The smaller diameter seal (light gray) is for cable diameters from 0.11 inch (2.8 mm) to 0.28 inch (7.1 mm). Two are supplied. Use one for the IRCON Sensor interconnecting cable. The larger cable seal (darker gray) is for cable diameters from 0.20 inch (5.1 mm) to 0.39 inch (9.9 mm). One is supplied. Select the fittings that match the user cable diameters to be installed.

1. The Strain Relief Figure 64 drawing illustrates how a braided wire shielded cable is grounded when using either the Grounding Strain Relief fittings.
2. Slip the Compression Nut (Item A) and the Compression Assembly (Item B) onto the cable, as in Figure 64. Pay attention to their order, position and direction of each part shown.
3. Unbraid and comb out the shield wires. Flare all the combed shield wires evenly all around, down, and over the Compression Fitting (Item B). If an inner foil is used in the cable, check that no inner foil drapes over the shield wires, trim it if necessary.
4. It is very important that the compression assembly rest on the un-stripped portion of the outer cable jacket to make a proper environmental seal.
5. Push the Compression Body (Item C), all the way, into the Compression Fitting (Item B). Carefully rotate until it seats properly.

6. Trim the shield wires to a spot just past the o-ring on the compression fitting, as shown in Figure 64.
7. Hold the cable firmly, so that the cable does not twist in the fitting, as you screw the Compression Nut (Item A) onto the Compression Fitting to make a watertight seal. Tighten all parts firmly.
8. The Locking Nut (Item D) is used to fasten the cable to the POI BOX.

Assembly Checklist:

- Check insulation resistance between all wires. Resistance should be 50 megohms or greater.
- Check closely for any wire strands that could cause shorting.

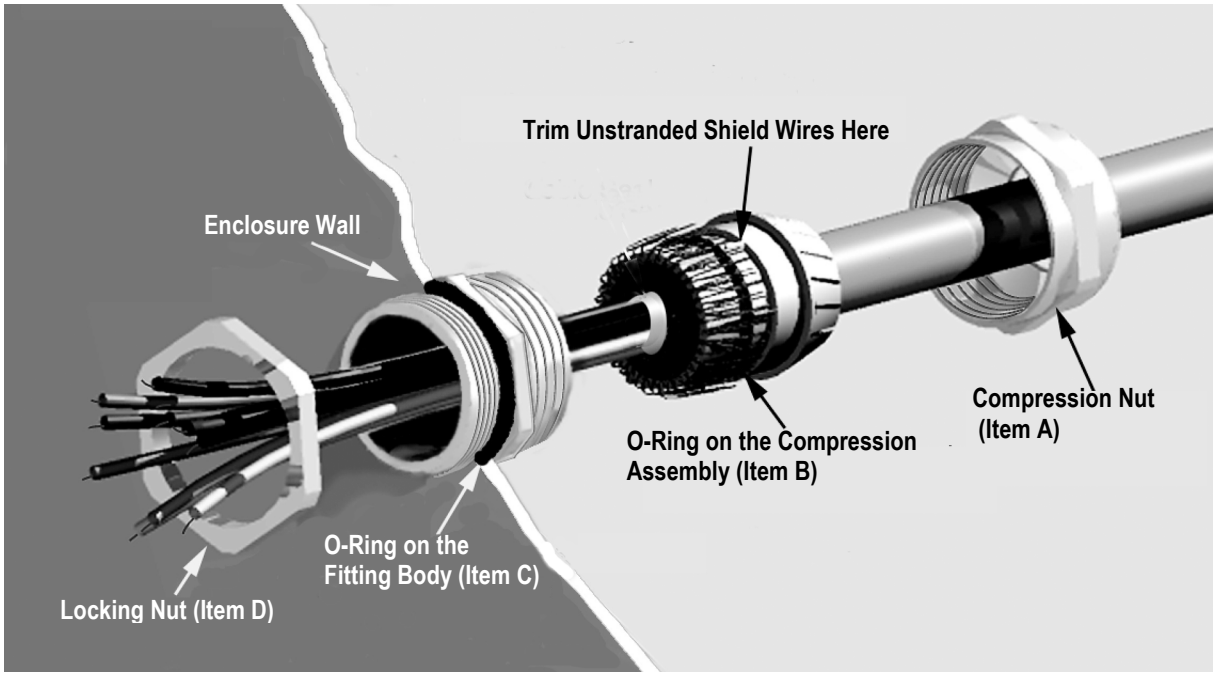


Figure 64: Grounding Strain Relief Fitting Assembly

4.7 POI Box – Sensor Interconnecting Cable Installation

For safety of personnel, AC power should not be applied to the POI box when its cover is removed. Use the power switch installed previously to disconnect power during wiring of the unit.

Remove the protective seal from the cable entry hole on the left side of the enclosure. The left side has a single entry hole in the center position. Insert the IRCON supplied interconnecting cable using the Grounded Strain Relief fitting into that hole, attach the locking nut to the fitting and tighten. Reference Figure 64 drawing in previous section.

Route all twisted wire pairs to their corresponding terminals identified by wire color. Insert the tinned wire ends of each color coded wire into its terminal and tighten.

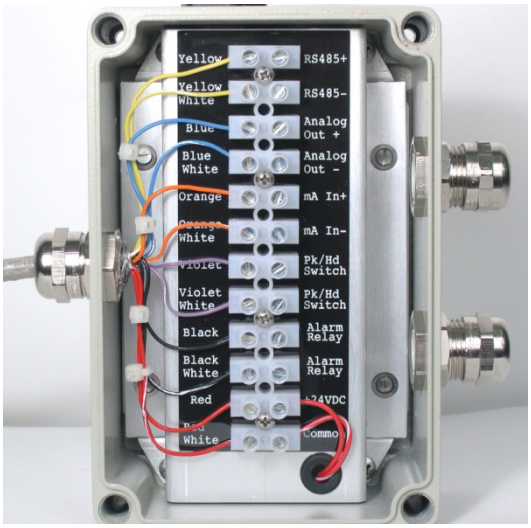


Figure 65: POI Box

4.8 Terminal Strip Plate – Sensor Interconnecting Cable Installation

Clamp the cable shield to the shield clamp on the left side of the Terminal Strip Plate.

Insert the 9.5 inches (241.3 mm) long Red and Red/White twisted pair through the ceramic ferrite core supplied with the plate. Keep the exposed wire length between the shielded cable end and the ferrite core as short possible. Maintain enough length to allow the core to be inserted into its mounting clip.

Bring the Red and Red/White pair around the outside of the core as tight and as close to the core surface as possible. Repeat until 2 wraps have been completed as shown.
Cut the pair to the required length for connection to the terminal strip. Strip wire 3/8 inch (10 mm) and tin with solder.

Route all twisted wire pairs to their corresponding terminals identified by wire color. Insert the tinned wire ends of each color coded wire into its terminal and tighten.

The 100 Ohm 1 watt fusible resistor placed from the ground stud to power supply common is not shown in these illustrations.

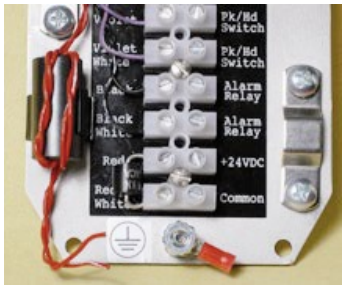


Figure 66

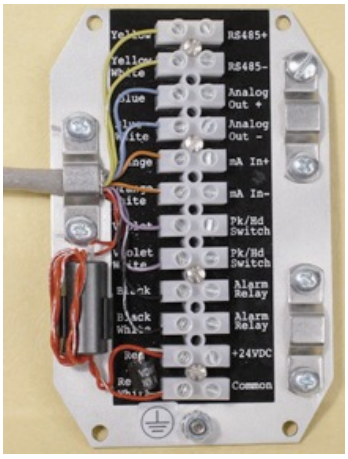


Figure 67

4.9 Connecting Device Cables to POI Box or Terminal Strip Plate

4.9.1 Recommended Cable Types

To maintain signal integrity and reduce noise pick-up, twisted pair shielded cables with overall foil and braid shielding should be used for connecting to all Sensor inputs and outputs. Belden low capacitance computer cable types 9829, 9830, 9831, 9832, 9839 and 9833, or equivalent cables are recommended. Each of these cables has a different number of wire pairs varying in quantity from 2 to 7 pairs.

The cable selected should have a twisted pair nominal impedance of 100 ohms and nominal capacitance between conductors should not exceed 15.5 pF/ft (50.9 pF/m).

All user-supplied cables should be grounded to the POI Box with one of the supplied Grounding Strain reliefs.

Two different size cable entry Grounded Strain Reliefs are supplied with the POI Box. The relief with the smaller diameter seal (light gray) is for cable diameters from 0.11 inch (2.8 mm) to 0.28 inch (7.1 mm). The larger diameter cable seal (darker gray) is for cable diameters from to 0.20 inch (5.1 mm) to 0.39 inch (9.9 mm). Select the fittings that match the cable diameters to be used.

Prepare the cables as explained in Section 4.6 Sensor Interconnecting Cable Preparation, page 69. Ground cable shields on the Terminal Strip Plate by inserting the prepared braid under the shield clamps.

4.9.2 Grounding and Shielding

Follow all grounding and shielding instructions provided below. Proper connection of the cable shields is important to avoid noise and ground loop problems that may cause errors. Do not connect cable shields at both ends. The use of the Grounding Strain Reliefs and cable shield clamps connect the shield to ground at the POI Box and Terminal Strip Plate side of the connection. The illustration below shows the shield not connected at the other end.

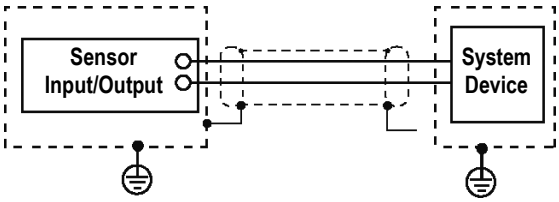


Figure 68

Refer to Section 4.14 System Grounding and Shielding, page 86 before beginning wiring. The section presents an overview on grounding and shielding and contains important information for wiring system cables.

4.9.3 System Connections

Refer to Manual Sections 5 Operation and 6 Digital Communications for Operation Information.

Yellow	⦸		⦸	RS485 +	RS485 Digital Communications
Yellow/White	⦸		⦸	RS485 –	
Blue	⦸		⦸	Analog Out +	4 – 20 or 0 – 20 mA output
Blue/White	⦸		⦸	Analog Out –	
Orange	⦸		⦸	mA In +	Remote Emissivity or E-Slope current input
Orange/White	⦸		⦸	mA In –	
Violet	⦸		⦸	Pk/Hd Switch	Can be used for Peak Picker Reset or Track Mode select or Remote Laser operation.
Violet/White	⦸		⦸	Pk/Hd Switch	
Black	⦸		⦸	Alarm Relay	Invalid Condition, Dirty Window and Sensor Error Code Alarm relay
Black/White	⦸		⦸	Alarm Relay	
Red	⦸		⦸	+24VDC	24Vdc Sensor Power Supply
Red/White	⦸		⦸	Common	

Table 15: Sensor Interconnecting Cable / Function

4.9.4 RS-485 Digital Communications

Connections are made on the terminal strip RS485+ (DATA) and RS485 – (DATA*) terminals. The Power Supply Common (-) terminal is used as the ground reference.

See Section 4.12 for detailed wiring of Sensors in a RS-485 multi-drop network. Section 6 of this manual details the RS-485 operation.

Maximum cumulative RS-485 cable length, from sensor to the actual process device, is 4000 feet (1220 meters).

4.9.5 Analog Output Temperature Signal

This current loop temperature signal is 4 to 20 mADC or 0 to 20 mADC, user selectable, linear with measured temperature. The corresponding temperature span is adjustable. Temperature signal connections are made to the Analog Output + and Analog Out – terminals.

Single or multiple series connected indicators, recorders or other instruments can be connected. The total current loop series DC resistance of all devices and wiring should not exceed 600 ohms.

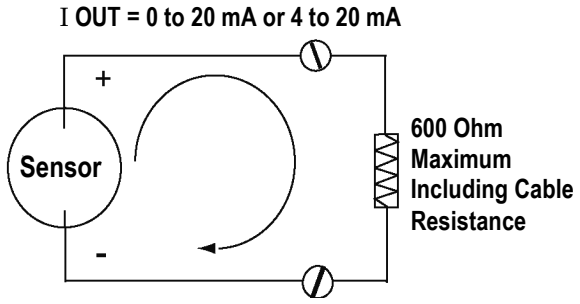


Figure 69

The minus side of the Analog Output is connected to power supply common (see section 4.14 System Grounding and Shielding, page 86). Use instruments with ungrounded differential inputs. If

instruments with grounded inputs are connected in the loop, the output may be inoperable or inaccurate.

If the Analog output is not used, insert a jumper wire or 100 Ohm to 500 Ohm value resistor across the output terminals. This will prevent an Analog Loop malfunction Alarm (Error X108) from occurring.

4.9.6 Converting the Analog Output from a mA output to a 10 Volt Output

To convert the Analog mA output to 0 to 10 Vdc Output, place a 500 Ohm resistor across the output terminals. The Sensor Analog output (SOUT) should be set to 0 to 20mA range.

The minus side of the Analog Output is connected to earth ground. Use instruments with ungrounded differential inputs. If instruments with grounded inputs are connected, the output may be inoperable or inaccurate.

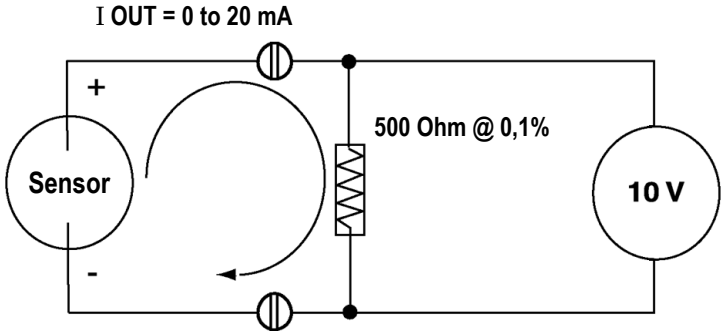


Figure 70

4.9.7 Current Input for Remote Emissivity, E-Slope or Laser Operation

You may make remote adjustments of the Emissivity or E-Slope by sending a scaled analog input of 4 to 20 mAdc. The Modline 5 senses an input and overrides any Sensor rear panel or RS-485 settings of Emissivity, E-Slope or Match.

The input can also be used for remote Laser operation.

Example for Emissivity:
A 4 mAdc signal corresponds to an emissivity setting of 0.100. A 20 mAdc corresponds to an emissivity of 1.000. The relationship for the values in between is linear.

Example for E-Slope:
For the E-Slope settings, the 4 to 20 mAdc signals correspond to settings of 0.800 to 1.200. The relationship for the values in between is linear.

Connections are made to Terminals mA In + and mA In –. Input impedance is 120 Ohms. Use Shielded cable and ground shields at POI BOX (with grounding strain relief supplied) or at the TSP Terminal Strip Plate ground terminal.

The (–) terminal of the mA input current input is isolated, but will only tolerate a difference of approximately 2 Volts between it and Sensor Common.

Remote Laser Operation is selected in COMMS – LASR Menu. See manual Sections 5.8 and 5.11 for selecting and operating this function. To configure and wire for remote I IN current/switch Laser operation follow the instructions given below. When selected for remote Laser Operation, Emissivity and E-Slope are not changed by the input current.

4.9.8 POI BOX or Terminal Strip Plate Current Input Terminal Connections for Remote Laser Operation

Use a DC power supply with a maximum output of 24 volts. Maximum input current allowed is 20 mA. Overloading the input can cause a Sensor Fail alarm.

When calculating a series resistor value to use with a supply voltage, subtract the 120 ohm Sensor internal circuit impedance from the calculated value. See Table below. On threshold is 15 mA.

DC Voltage Supply	Resistor Value
10 Volts	560 ohms (Plus 120 Internal = 680 ohms total) for 15 mA
24 Volts (Can be Sensor Supply)	1500 Ohms (Plus 120 Internal = 1620 ohms total) for 15 mA

Table 16

Connect the supply circuit as shown in the wiring diagram. The I IN – terminal can be connected to a floating or earth grounded power supply terminal. In either case, it must be connected directly to the power supply. If using the POI BOX internal 24 VDC power supply, common must be directly connected to the mA – terminal.

Mount the ½ Watt resistor in a series circuit on the switch or at the external power supply location.

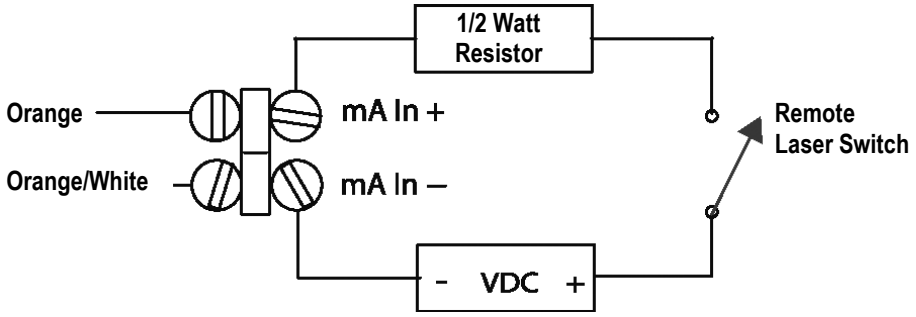


Figure 71

4.9.9 Peak/Hold Switch for Remote Peak Picker Reset, Track and Hold or Laser Operation.

An external switch connected to the Pk/Hd Switch terminals will control signal conditioning of the Modline 5. These terminals can also be used for remote Laser activation.

Switch action for the Peak Picker will provide the following control. Momentary closure of the switch (>0.08 second) immediately resets the Peak Picker. If the switch is continuously closed, the Temperature Display will show direct readings without any Peak Picker signal conditioning. The switch may be manually operated or it may be a contact on a timer, relay, or any other process operated switch.

Switch action for Track and Hold will provide the following control. With the switch open, temperature tracking continues (Track). With the switch closed, the displayed temperature will be held at the last reading (Hold). The switch may be manually operated or it may be a contact on a timer, relay, or any other process-operated switch.

Remote Laser Operation is selected in COMMS – LASR Menu. See manual Sections 5.8 COMM – Setup of RS-485 Digital Communication Configuration, page 103 and 5.11 Laser Sighting Operation, page 110 for selecting and operating the remote laser function. The PkHd terminals are dedicated to Laser operation when selected. To wire for remote PkHd switch operation follow the diagram given below.

Use Shielded cable and ground shields at POI BOX (with grounding strain relief supplied) or at the TSP Terminal Strip Plate ground terminal.

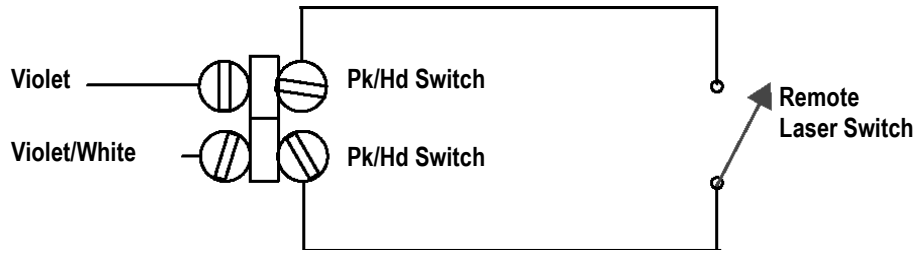


Figure 72

4.9.10 Sensor Alarm Relay Contacts

The sensor self tests its case temperature, detector assembly temperature, output current flow, etc. The Check function checks internal circuit and detector operation. The optional Dirty Window Detector measures the Sensor's window condition. One or more out of limit conditions sensed by these tests triggers an Alarm and operates the Alarm relay within the Modline 5. The relay contacts may be used in the process control system to indicate measurement conditions do not allow process temperature measurements or Sensor operation may be impaired. Appropriate action for the various conditions can then be initiated.

Alarm Relay contact connections are made to the Alarm Relay Terminals. The relay contact is rated for 24 Volts AC or DC, 1 AMP resistive loads only.

The Alarm relay can be configured for Normally Open or Normally Closed operation. The configuration can be performed at the Sensor Rear panel with the Engineering RELY function, or with RS-485 digital communications.

Set the relay operation to correspond to proper and safe use of the contacts in your overall measurement system.

Select N C. for closed relay operation with Sensor not in Alarm condition (open in alarm state).

Select N.O. for closed relay operation with Sensor in Alarm condition (open when not in alarm condition).

Contacts are held open for both N.O. and N.C. operation when the Sensor is not powered, and, for 3 to 5 seconds after power is applied to the Sensor during the initiate period. Normally Closed N.C, operation is considered fail-safe operation.

The table below details the alarms and measurement conditions that trigger the Alarm Relay. Details about these Alarms are found in Section 7 Maintenance, page 127.

Sensor Error Code Alarms

X101	Dirty Window Detection
X102	Out of calibration
X103	Detector block too hot
X104	Detector block too cold
X105	Case temperature too high
X106	Case temperature too low
X107	Sensor failure FAIL may be seen on the Sensor TEMP display
X108	Analog Output Current loop malfunction (open circuit)
X109	Dirty Window Detection malfunction

Measurement Condition Alarms

INV	Measurement Conditions are invalid for two color ratio temperature measurement. When the Invalid Alarm (iALM) function is set to ON, this measurement condition becomes an alarm and triggers the Alarm relay and the ALARM word on the Sensor rear panel
pINV	pINV is only displayed when the Invalid Alarm (iALM) function is set to ON and Peak Picker or Track and Hold is On, this condition becomes an alarm and triggers the Alarm relay and the ALARM word on the Sensor rear panel. Temperature displayed is Peak Picked or Hold Mode Temperature values from prior valid measurement conditions.

4.10 Selection of a Power Supply for Sensors used with TSP Terminal Strip Plates

When using a Modline 5 Sensor with the TSP Terminal Strip Plate, select a switching type power supply that will provide reliable startup. The power supply output should remain at rated voltage during the Sensor current loading that occurs at startup. Sensor displays and alarms will not properly start with low voltage.

A dedicated Power supply for each Sensor is the simplest and best configuration. IRCON offers a chassis mount single sensor supply. The IRCON part number for this power supply is 551632. See Section 4.11 Installing and Wiring the Chassis Mount 24 Volt DC Switching Power Supply for all details.

Multiple Sensor installations may require more than one power supply. A single supply will not be able to properly provide startup power to a large number of sensors. Limit the number of Sensors supplied from a single power supply to no more than 2 or possibly 3. Dividing the Sensors into groups can eliminate long cable runs when sensors are installed at distant locations. This is especially the case when AC power is available locally.

The standard Modline 5 cable that is routed between the Sensor and TSP Plate is limited to 350 Feet (107 meters). The power supply wires in this cable are 22 gauge. This maximum cable distance and wire gauge assures enough voltage will be available at the sensor. The voltage drop developed across the power supply wire pair will be small and not cause a low voltage condition.

Whether powering a single Sensor or multiple Sensors, there may also be significant voltage drops across the wires connecting the power supply to each TSP. Keep the wire lengths between the power

supply and Terminal Strip Plate short. The voltage drops developed are dependent upon length and gauge of the wire.

A qualified electrician or technician should apply power with the all sensors connected and measure 24 VDC, +/– 5%, at the Red and Red/White power supply terminal connections on the left side of each TSP Terminal Strip Plate.

A 100 Ohm1 Watt fusible resistor is supplied with all TSP plates to connect power supply common to earth ground as shown in the diagrams. The 100 Ohm resistor is built into the POI Power Supply / Signal Interface Box.

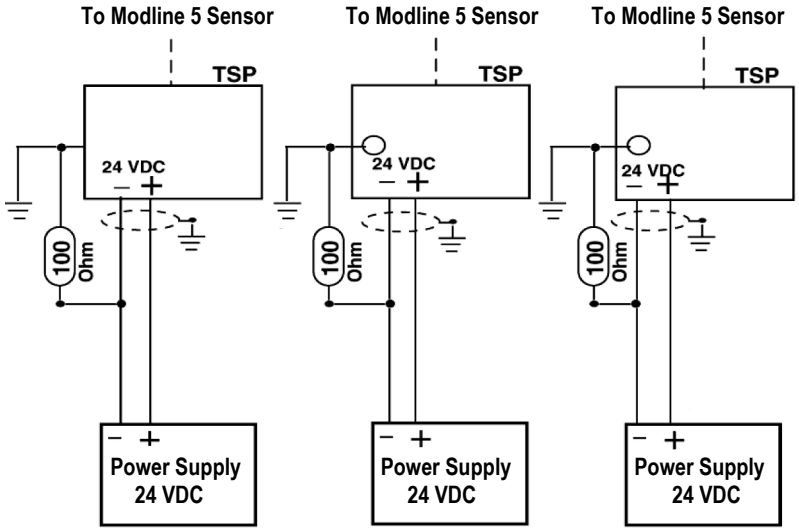


Figure 73: Sensor Wiring one 24 VDC Supply for each Sensor

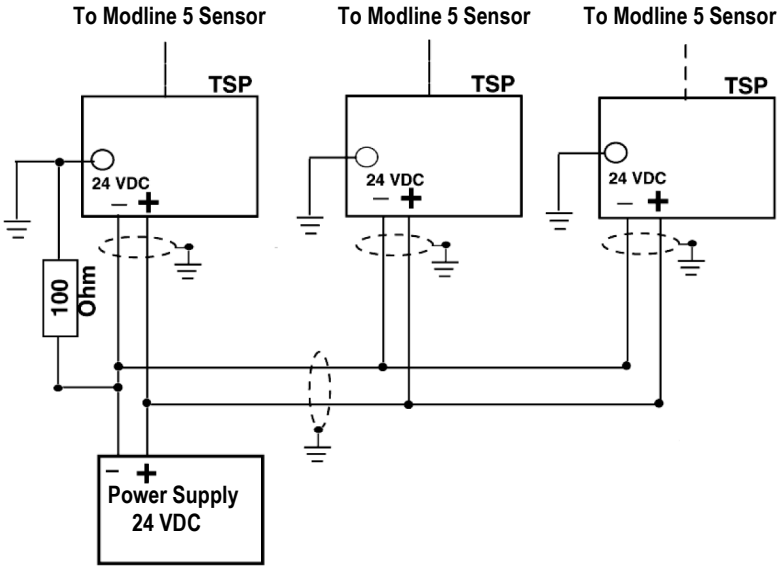


Figure 74: Sensor Wiring one 24 VDC Supply and Three Sensors

4.10.1 TSP Terminal Strip Plate DC Power Supply Connections

These instructions are for the Terminal Strip Plate only. The POI Box has its own internal Power Supply that is connected to the right side of the Terminal Strip in Section 4.4.

See Section 4.5 to review Terminal Strip Plate enclosure, power supply and ground connection requirements.

Section 4.11 provides instructions for using a chassis mount 15 watt, 24 Volt DC Switching Power Supply supplied by IRCON. The part number for this power supply is 551632.

The external 24 VDC power is wired to the right side of the Terminal Strip. Use 22 AWG (0.35 mm²) wire. Total power supply cable run using 22 AWG (0.35 mm²) wire is 107 meters (350 feet). Shielded cable is recommended. Paralleling two pairs of 24 AWG (0.25 mm²) cabling is equivalent to using 22 AWG (0.35 mm²) cable.

Connect the positive side of the 24 VDC power source to the +24VDC Terminals.
Connect the common or negative side of the source to the Common Terminal.

4.10.2 Power Supply Common Ground Connection

The Common side of the power source must be connected to earth Ground. If the dc power source common is not already connected to ground at some point in the system, make the connection at the Terminal Strip Plate.

The recommended and preferred method of making the ground connection to is to connect the power supply Common Terminal to Ground through a 100 Ohm 1 Watt fusible resistor The resistor is inserted between the Ground Stud and the Common Terminal.

4.11 Installing and Wiring the Chassis Mount 24 Volt DC Switching Power Supply

The part number for this power supply is 551632. This is the same chassis mount 15 watt, 24 VDC switching power supply used in the POI Power Supply/Signal Interface Box. The supply powers one Modline 5 Sensor and must be used with the TSP Terminal Strip Plate (supplied separately). The power supply module operates with 100 to 240 VAC power, 50/60 HZ. Nominal continuous input current is 0.3 A.

The power supply module and TSP are shown in Figure 75. These component parts must be installed in a grounded metal enclosure for safety and electrostatic protection. Select enclosures designed for electrical use with the NEMA and IP environmental ratings required at the point of installation. The rectangular mounting hole layout dimensions for the module are 3.39 inches (86 mm) by 1.81 inches (46 mm). Module height is 1.04 inches (26.5 mm).

Design and implementation of the installation must be performed by qualified personnel. Installation instructions and important warnings are included in the carton with the power supply. Further instructions are provided on the power supply manufacturer's website.

It will be useful to review Section 4.4 Model POI Power Supply/Signal Interface Box, page 63. Wiring and installation of the TSP Terminal Strip Plate is covered in Sections 4.5, 4.6, 4.8, 4.9, 4.10 and 4.14.

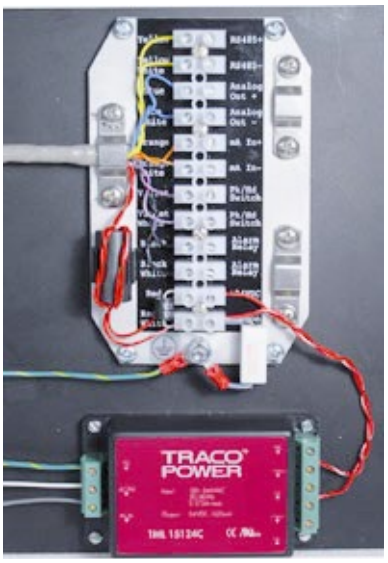


Figure 75

Compliance with relevant national regulations in the USA, Europe and the other countries must be ensured. Adhere to all safety and local electrical codes. Before operation is started, the following conditions must be ensured:

Connection to mains supply in compliance with national and local regulations. Mains cables must be sufficiently fused.

Supply a two-pole switch for 100 VAC to 240 VAC at 50 to 60 Hz. The switch should be clearly marked as the power shutoff for the equipment, visible and accessible to the operator.

Install in environments where the power supply enclosure will not exceed 55°C (131°F). Keep away from fire and water.

Tinned stranded 18 AWG (1 mm²) wire for AC power and ground connections is recommended (terminals accept 16 AWG wire maximum). Strip insulation from wires 1/4 inch (8 mm). Connect the LINE and NEUTRAL wires of the AC power line to the power supply module as indicated on the module, LINE to AC (L) and NEUTRAL to AC (N).

The non-fused protective earth ground connection must be connected to the FG terminal of the module (Protection Class 1). Ground wire must be the same size or larger than AC power wires.

Use tinned stranded 22 AWG (0.35 mm²) wire for the 24 VDC plus and minus connections to the TSP. Observe polarity.

Improper installation or operation can result in serious injury or death to personnel! The installation should be performed following all national and local electrical codes. Never work on the power supply if mains power is supplied. Do not open the power supply until at least 5 minutes after it has been disconnected from the mains on all poles.

4.12 RS-485 Multi-Drop Network Power Supply and System Wiring

Multiple Modline 5 Sensors communicating via RS-485 with a Host device are installed in a multi-drop network configuration. The Modline 5 MSI Multiple Sensor Interface, a PC, a PLC or other Control system are Host devices. A block diagram of a multi-drop network is shown in the adjacent illustration. It is important to wire the network properly to prevent noise pickup and have reliable operation.

Sensors should be wired in tandem as shown in the diagram. The RS-485 terminals from the Sensor furthest from the host device are wired to the next closest Sensor. Then the RS-485 Terminals of that Sensor should be wired back to the next closest sensor. Do this until all sensors are wired. Do not use any other configuration.

A 120 ohm termination resistor should be placed across the RS-485 terminals of the Sensor furthest from the Host device as shown in the diagram. Consult the manual for the Host device to determine if any termination resistor is required at its terminals. The IRCON Model MSI Interface does not require a termination resistor at its input.

To maintain signal integrity and reduce noise pick-up, twisted pair shielded cables with overall foil and braid shielding should be used for connecting to all Sensor inputs and outputs. Belden low capacitance computer cable types 9829, 9830, 9831, 9832, 9839 and 9833, or equivalent cables are recommended. Each of these cables has a different number of wire pairs varying in quantity from 2 to 7 pairs.

The cable selected should have a twisted pair nominal impedance of 100 ohms and nominal capacitance between conductors should not exceed 15.5 pF/ft (50.9 pF/m).

Select power supplies and install cables as instructed in previous sections of the manual.

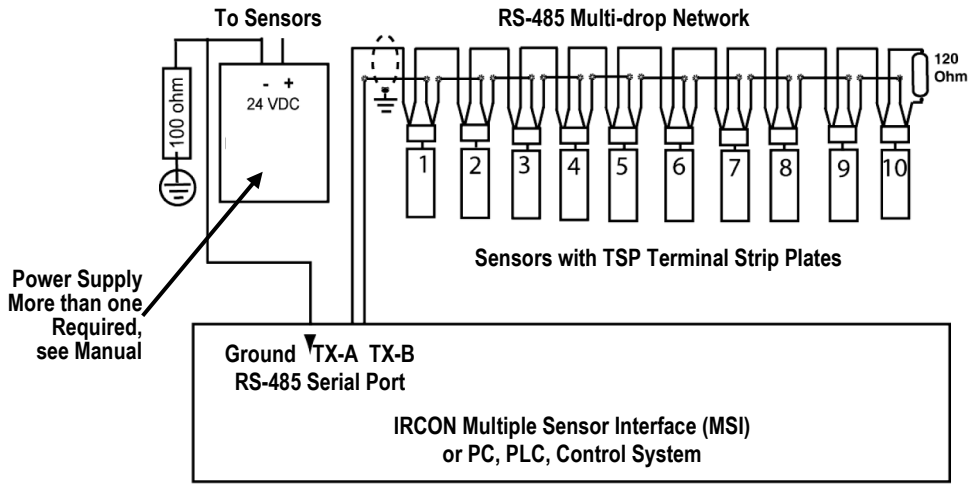


Figure 76

4.12.1 Computer Communications Requirements

The Host device communicating with The Modline 5 Sensor should have an RS-485 communication port. If not, an RS-232 Port and a RS-485 to RS-232 converter can be used. An RS-485 to USB converter can also be utilized. The combined communications port and converters used must have the capability to communicate over a 2 wire, half duplex RS-485 network at **speeds fast enough to handle command requests with reply turn around times of one-millisecond or less**.

The following converters will provide satisfactory performance when used with Modline 5 Sensors.

CyberResearch Inc.
Contact: www.cyberresearch.com
Superverter™ Model 285 R-422/RS-485 to RS-232 Converter.
CyMOD™ Model CM 4530 USB to RS-232/422/485 Converter with isolation.
(Superverter and CyMOD are trademarks of CyberResearch Inc.)

DGH Corporation
Contact: www.dghcorp.com
A1000 and 2000 Series (The A1000 will also provide 24 Volt DC power for 3 Sensors)
RS-232/RS-485 Converters and RS-485 Repeaters

Black Box Corporation
Contact: www.blackbox.com
RS-422/485 PCMCIA Serial I/O Adapters, Single-Port
Product Code IC114A-R2 (for laptop computers)

See Section 6 of this manual for Modline 5 Sensor communications details and commands.

4.12.2 POI Power Supply/Operator Interface Box Multi-drop Wiring

A block diagram of a multi-drop network using POI Box interfaces is included on below. The 100 Ohm resistor is installed inside each POI Box, do not install one externally.

Use the shielded cable specified in the previous manual sections.

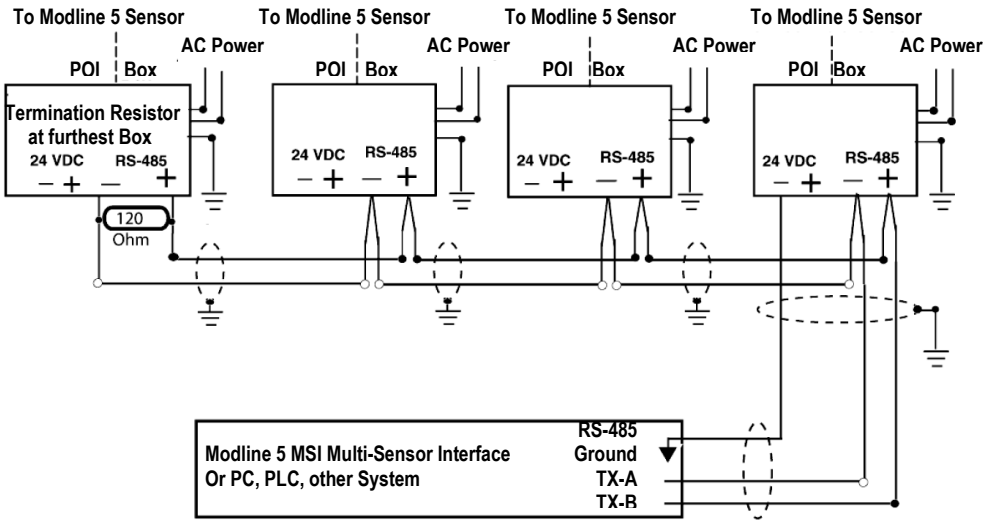


Figure 77: Four Sensor RS-485 Multi-drop with POI Power Supply Operator Interface Box

4.12.3 TSP Terminal Strip Plates Multi-drop Wiring

These illustrations indicate the proper wiring when using TSP Terminal Strip Plates. A power supply for each Sensor and TSP pair is shown in the first illustration. This is the preferred method.

A single power supply is shown powering three Sensors in the second illustration. A power supply should not power more than 2 or 3 Sensors.

Use the shielded cable specified in the previous manual sections and install termination resistors as required.

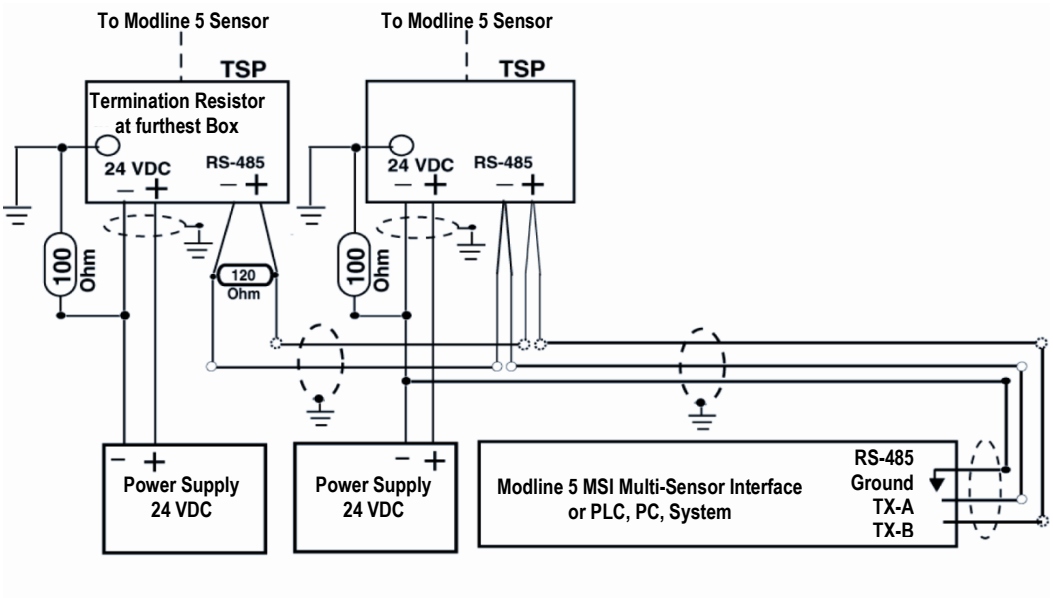


Figure 78: Multidrop Sensor Wiring with 24 VDC Supply for each Sensor

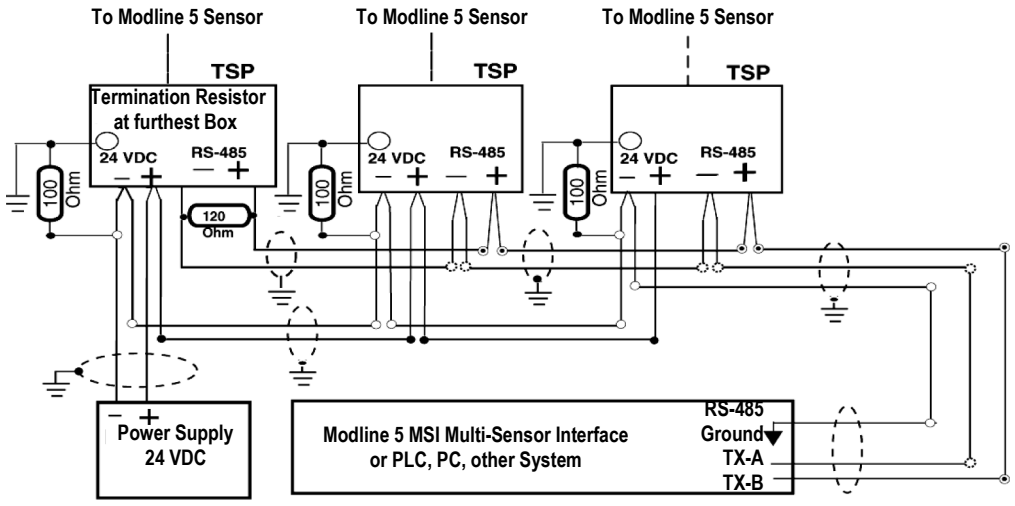


Figure 79: Three Sensor RS-485 Multi-drop with 24 VDC Supply and TSP Terminal Strip Plates

4.13 Sensor and Cable Connection

4.13.1 Cable Plug and Sensor Receptacle

Position the red dot on the interconnecting cable plug on connector to match the red dot on the Sensor housing receptacle. Push the connector firmly and completely in to the Sensor receptacle.

The cable plug and Sensor receptacle combination are NEMA 4 (IP65) rated. However, provide protection for the plug and receptacle if they are disconnected and the contacts and pins are exposed to harsh environments.

Make sure the 24Vdc power to the Modline 5 Sensor is turned off whenever connecting and disconnecting the cable.

Make sure the rear protection window is in place after making adjustments to maintain the Sensor's NEMA 4 (IP65) environmental rating.

Figure 80

4.14 System Grounding and Shielding

4.14.1 POI Box and Terminal Strip Plate Diagram

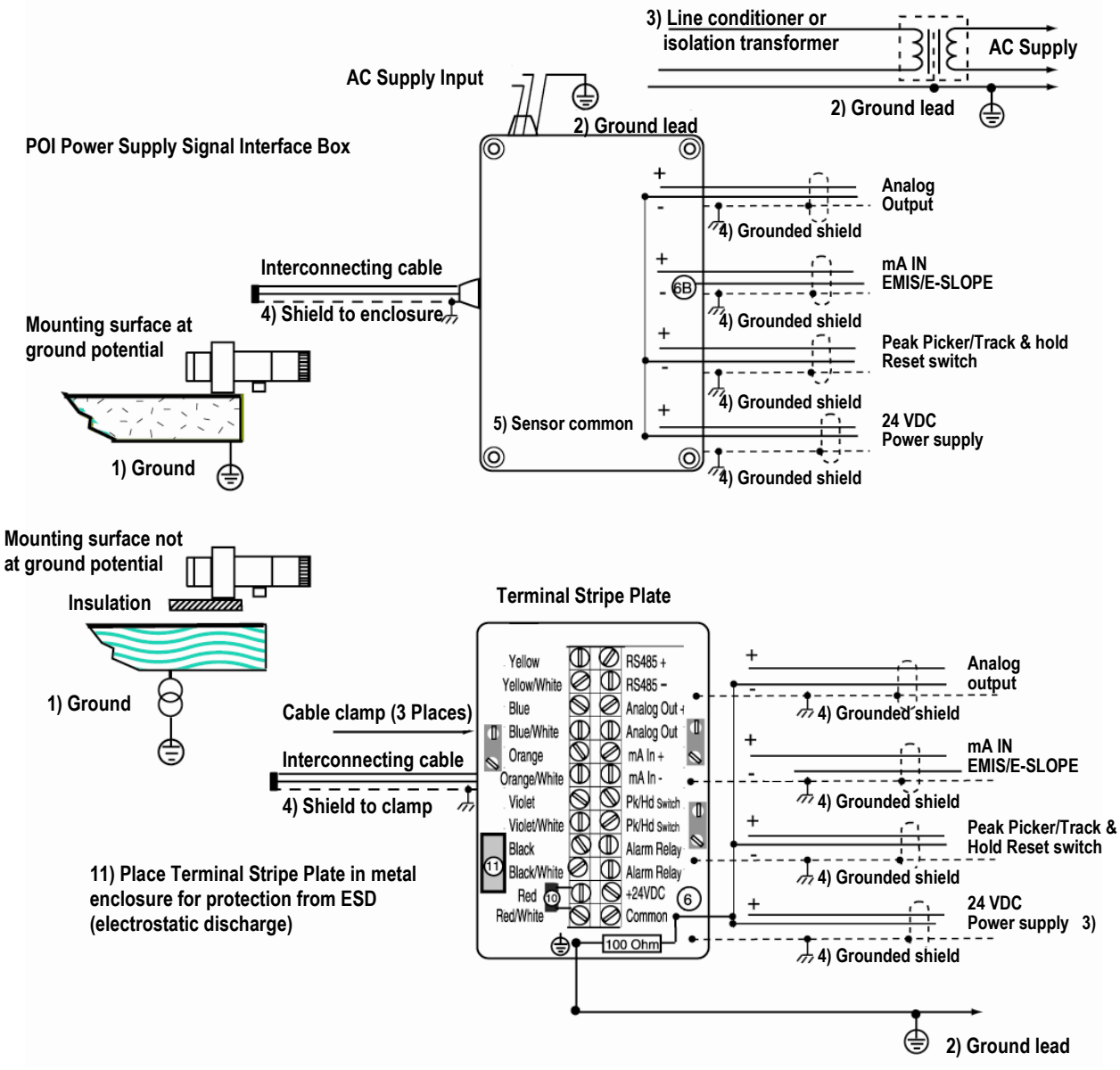


Figure 81: POI Box and Terminal Strip Plate

1) **The Sensor mounting surface should be at earth ground potential ⏚. Provide electrical insulation between the Sensor and mounting surface if the surface is not at ground potential. Use non-conductive hardware for mounting. Mounting surfaces not at ground potential could be hazardous for personnel operating and maintaining the Sensor.**

2) **Insure earth ground ⏚ is properly connected to the POI Box enclosure or the Wiring Terminal Plate as previously instructed in this Section.**

3) For the POI Box: Use a clean AC Power line free from noise and transients. If a line conditioner or isolation transformer is used, connect per manufacturer's instructions. These devices must withstand the inrush current specified in Section 4.4.2 AC Power and Earth Ground Connections, page 65. Earth ground must be properly connected.

   For the Terminal Strip Plate: Connect a regulated power supply.

4) The Sensor case is connected to the shield of the interconnecting cable. The cable shield connects to the grounded POI Box enclosure with the Grounding Strain Reliefs.

   If the Wiring Terminal Plate is used, the interconnecting cable shield is connected to ground with the shield clamp on the plate.

   Twisted pair shielded computer cable is required for all connections. Ground the cable shields at the POI Box with the supplied Grounding Strain Reliefs.

   If the Wiring Terminal Plate is used, cable shields are connected to ground with ground clamps on the plate.

   This manual specifies the shields of cables connecting between the POI Box or Terminal Strip Plate and system devices be connected to ground only at the Box or Plate. The recommended shield connections are shown in the drawing below. This recommendation is to prevent ground loops due to the difference in ground potential between locations of components and provide adequate shielding of cables.

   Some devices call for connecting the shield to ground at the device input. If ground loops develop with this connection, it may be necessary to experiment with shield connections. The ground connection at the Terminal Strip Plate or POI Box and the interconnecting cable shield should always be connected!

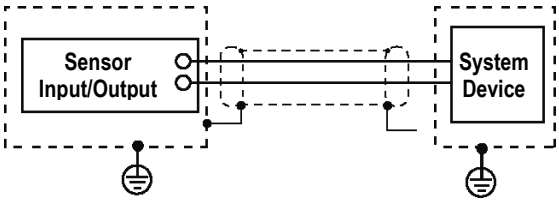


Figure 82: Sensor shield

5) Several Sensor circuits are connected to an internal common. The minus (–) or common terminals for the 24 VDC Power Supply, Peak Picker/Track and Hold Switch, and Analog Output are connected internally.
   A.) Connect the Analog Output to devices with differential inputs that have not been grounded.
   B.) The (–) terminal of the mA input for remote Emissivity and E-Slope current input is isolated but will only tolerate a difference of approximately 2 Volts between it and Sensor Common. Input impedance is 120 Ohms.
   See Note 8 for connecting Common to ground

6) The RS485 Data connection is not isolated. Use an external isolator if isolation is required.

7) **Alarm Relay contacts are isolated from ground and Sensor internal common.**

8) **For the POI Box: A 100 ohm 5 watt resistor is connected between the Sensor internal common to earth ground. For practical purposes, the minus terminals connected to the internal common should be considered grounded.**

   For the Terminal Strip Plate: Depending on the installation, the internal common will be connected to ground through a 100 Ohm 1 Watt fusible resistor.
   See Section 4.10 for details.

9) **The Terminal Strip Plate is supplied with a transient suppressor across the Red and Red/White power supply wires on the left side of the terminal strip.**

10) **The Terminal Plate is supplied with a ceramic ferrite bead for the Red and Red/White power supply wires.**

11) **The Terminal Strip Plate must be placed in a metal enclosure for protection from electrostatic discharge (ESD).**

4.15 Summary Caution and Warning

Inspect the installation for proper wiring, possible loose connections or potential shorts.

The installation of the Sensor described in Section 3 Sensor Installation, page 22 should be complete. The wiring of the Sensor and system devices described in this Section 4 Sensor Wiring, page 62. should also be complete. The Modline 5 Sensor can now be powered and the initial setup for operation performed as described in Section 5 Operation.

Look for any signs of over heating or smoking when applying power. Investigate any signs of improper installation

Please read the following important Caution and Warning.

If you observe any signs of malfunctions smoke or overheating; complete lack of any indication; etc. - turn off power immediately. Recheck all wiring, and refer to Section 7.6.1 for troubleshooting.

Critical Process Safety Guideline

Risk of Personal Injury
When this instrument is being used in a critical process that could cause property damage and personal injury, the user should provide redundant device or system that will initiate a safe process shutdown in the event that this instrument should fail. The user should follow NEMA Safety Guidelines For the Application, Installation, and Maintenance of Solid State Control.
A copy of the guidelines is reprinted in Appendix A.

The National Electrical Manufacturers Association, NEMA, has published safety guidelines for the Application, Installation and Maintenance of Solid State Control. The thrust of this document is personal safety. The guidelines contained in this document should be followed for critical processes that depend upon the operation of this instrument.

The user should provide a redundant system or device that will initiate a safe process shutdown in the event that this instrument or associated system should fail. The control of a process should not

be solely dependent upon this instrument and its peripheral components. Other measuring and controlling safe-guards should be included in a redundant system designed to provide warning of conditions that may cause personal injury or property damage. These safeguards should be in place at all times, including startup and shutdown, as well as normal operation.

Procedures should be in place that verify proper instrument and system operation after service, maintenance or replacement to insure the instrument and peripheral components are returned to service properly. All alignments, settings and connections required for proper operation must be performed or verified.

A computer with specialized software may be used as an operator interface for setup and operation of the system. Digital and analog communication with alarms and controllers may be part of the system making it a more complex system. Changing software configurations and settings requires that process performance be verified.

5 Operation

5.1 Sensor Rear Panel Setup and Operation

5.1.1 Introduction

Become familiar with the displays, pushbutton controls, menus and the functions required for Sensor setup and operation as described below. Modline® 5 instruments are thoroughly tested and calibrated to factory specifications before shipment and should require no more than brief function selections and adjustments to meet the requirements for measurement of process temperatures.

5.2 Rear Panel Keyboard, Displays and Sight and Laser Aiming

5.2.1 Description

Located on the rear of the Modline 5 Sensor are: a keyboard panel with three setup pushbuttons, three red word indicators for **Setup**, **Alarm** and **Window** (for the Dirty Window Detector optional feature), and a four character green alphanumeric Light Emitting Diode dot matrix display with adjacent green **°F** and **°C** indicators.

The display is identified as the Temperature (**TEMP)** display in this manual. The TEMP display and **°F** and **°C** indicators are used for temperature indication in Fahrenheit or Celsius. **LOW** or **HIGH** is displayed when viewing target temperatures below or above the Sensor temperature range. **INV** is presented on the display for Invalid ratio temperature measurement conditions. Setup parameters will be shown on the TEMP display during setup and error codes displayed in response to an Alarm inquiry.

Two of the pushbuttons are Down / Up Arrows labeled ▼ and ▲. The third is an Enter pushbutton labeled **ENT with the keyboard enter symbol** ↵. These buttons are identified as ▼▲ and ↵ in this manual.

A sight for visually aiming the Sensor is located in the center of the keyboard. The process target and Sensor circular reticle can be seen when viewing through the sight. Sensors with the Laser aiming option have a pushbutton to energize a laser in place of the sight.

Access to the keypad requires removal of a screw on protective window with O-ring gasket. The protective window must be in place during temperature measurement to maintain the NEMA 4 (IP65) Sensor housing rating.

Temperature in °C or °F

LOW = Below zero scale temperature
HIGH = Above full scale temperature
INV = Invalid Condition for Ratio Temperature Measurement

Figure 83: Sensor with Visual Through the Lens Sight

Figure 84: Sensor with Laser Through the Lens Aiming Option

Laser pushbutton is located on the edge of rear panel. Visual sight is not available with this option installed. LED above pushbutton is on when laser is energized.

See Section 5.11 Laser Sighting Operation, page 110 for complete Laser operation and safety instructions.

5.3 Navigation and Menus

5.3.1 Enter and Up / Down Arrow Pushbuttons

Up and Down Arrows ▼▲ are inoperative during valid temperature measurement. Arrows are operable when an Alarm Condition has been sensed and the ALARM indicator is lit. Depressing the UP Arrow ▲ will display an error code. **The Up Arrow should be depressed multiple times to view simultaneous multiple Error Codes that might occur. If multiple errors have been displayed, the Down Arrow ▼ will scroll backwards through the errors**. To return to the TEMP display while viewing an Error Code, press Enter ↵. If no button is pressed after 15 seconds, the display returns to the temperature display.

The ENT (↵) pushbutton is also used to navigate from the TEMP display to the Main Setup Menus. Up and Down Arrows ▼▲ and the ENT pushbutton are used to View, Select and Adjust Sensor Functions.

ENT (↵) must be momentarily depressed (less than 5 seconds) when changing function values and making selections. If ENT (↵) is held depressed for 5 seconds, all adjustments made in the current menu are canceled and the unit returns to the TEMP Display.

5.4 Main Menus

Navigate from TEMP display, by pressing ENT ↵ once. The last selected Main Menu will be displayed. USE the UP / Down Arrows ▲▼ to step through and view the following four Main Menus. Menus are displayed for 15 seconds before returning to the TEMP display if no further selection is made.

ENGR (Engineering)
AOUT (Analog Output)
COMM (RS-485 Communications)
HEAD (Operation Functions)

Operation

At a Main Menu, Press ENT ↵ once to enter the Menu. One of the Function selections will be displayed. USE the UP / Down Arrows ▲▼ to view a different Function. Functions are displayed for 15 seconds before returning to the TEMP display if no further selection or adjustment is made. The main menu functions are shown below. Some functions are model specific and only appear for those models.

ENGR (Engineering Functions)

LOCK (Panel Access Security Setup)
VER (Sensor Firmware Version)
MODL (Model Number Scrolling)
RELY (Alarm Relay Operation Setup)
F/C (°F and °C Selection)
CHK (Initiate System Check)
HOUR (Automatic System Check Setup)
WRNL (Optional Dirty Window Detector Setup)
iALM (Sets Ratio Sensor Invalid Condition as Alarm)

AOUT (Analog Signal Output Selection and Scaling)

SOUT (Select Analog Output Current Range)
ZERO (Set Analog Zero Scale Temperature)
FULL (Set Analog Full Scale Temperature)
Fatl (Set Output Current for Sensor or DWD Error)
A–LO (Set Alarm Current Output for Temperature Below ZERO)
A–HI (Set Alarm Current Output for Temperature Above FULL)

COMM (RS485 Digital Communications)

CLCK (Communications Lock, Read Only or Read and Write Setup)
LASR (Select Laser Sight Activation Mode)
ADDR (Set Sensor Address)
BRAT (Set Baud Rate)

HEAD (Sensor Operating Functions)

EMIS (Set Emissivity for Brightness or 1 Color Sensor)
E-SL (Set E-Slope for 2 Color Ratio Sensor)
R.T. (Set Response Time)
SIGL (Signal Conditioning Peak Picker or Track/Hold)
PSEL (Peak Picker Sub Function Settings)
COLR (Set Ratio Unit for 2 Color or 1 Color Operation)
MTCH (Match Known Temperature)

SUB FUNCTION PSEL (Peak Picker Function Settings)

D.R. (Decay Rate in ºF or ºC per Second)
AUTO (Auto Peak Picker Reset)
RSET (Manual Peak Picker Reset)
RBEL (Reset Below Temperature)
DEL (Peak Signal Conditioning Delay)

5.5 Warm-up and Initial Setup

5.5.1 Series 5R, 5G, 52 Power On and Warm-up

When power is applied to the Sensor, a three to five second initiate condition occurs. All segments of the dot matrix TEMP display, and all word and symbol indicators are lit. The alarm relay is always held **open** during this short period.

After application of power, a warm-up time of approximately 5 to 15 minutes is required for the Sensor's infrared detector and/or electronics. The Sensor Rear Panel Alarm indicator will be lit and Error Code X104 (Detector Cold) displayed when the ▲ arrow is depressed. During the warm-up time, temperature measurements can be made and outputs are operational. However, the Alarm signifies that the temperature indication may not be accurate. Temperature indications will be accurate after the Alarm indicator has turned off when warm-up is completed. If there is a brief power outage, Sensors may restart and go into the initiate and warm-up conditions described above.

The Sensor Check function should not be initiated until the Sensor has warmed up and the Alarm indicator has turned off. An Out of Calibration Alarm (X102) may occur if initiated during warm-up. If this Alarm occurs, repeat the Check.

5.5.2 Series 56 Models Power On and Warm-up

Series 56 Models include a Self Calibration feature which is performed as part of the power on routine.

5.5.3 Initial Rear Panel Display

After the warm-up period is over, you should observe one or more of the Modline 5 Sensor responses described below on the TEMP display and at the outputs. During initial setup, because the Sensor is not adjusted for the process, these initial displays are expected.

1.Target Within Range — If the Sensor is viewing a temperature within its range, it will display a temperature value. Equivalent analog signals will be supplied to any devices connected to the analog outputs (e.g., recorder or remote indicator). If initial setup has not been set to match operation to the process, the displayed temperature and analog outputs will not be a true measurement of the target temperature.

2. LOW / HIGH Indication — If the measured temperature is below or above the Sensor temperature range limits LOW or HIGH will be shown on the temperature display. The Alarm Indicator does not light because these are normal conditions.

3. INVALID — An Invalid condition will be indicated any time the sensed infrared radiation is considered to be inadequate for two color Ratio Sensor measurement. The word INV is indicated on the TEMP display. If the Invalid Alarm (iALM) is set to On, the Alarm Relay will be in alarm condition and the word Alarm lit on the Sensor rear panel.

5.5.4 Initial Sensor Setup

Initial Sensor setup should follow the menu orders indicated in the following instructions. Menu navigation is shown using the ↵ &▲▼ symbols for Enter and Up / Down arrows. The menus and functions available and the sequence in which they appear depends on the Sensor Model and the purchased options.

A function variable is expressed as a word or as a number. A function variable may be changed from State A to State B or from a higher or lower numerical value by using the Up / Down arrows.

Momentarily depress the Up or Down Arrow pushbutton to make single digit changes starting with the least significant digit. Keep the pushbutton depressed to quickly change values.

All values are retained in non-volatile memory and are automatically reloaded, in the event of a power loss.

Temperature measurement continues during menu operations and changing of function values. The Analog Output and RS-485 temperature indications continue to reflect changes in target temperatures. When a changed function value that affects the measured and displayed temperature is entered with the ENT ↵ pushbutton, the temperature reading at the outputs updates in about 150 milliseconds.

5.6 ENGR – Setup of Engineering Functions

5.6.1 LOCK – Panel Lock Security

In the Panel Lock "Off" state viewing and adjustment access to all menus and functions is allowed. In the "ON" state, viewing all menus and functions is allowed, but changes are not allowed. This prevents unauthorized changes. Panel lock does not interfere with temperature measurement.

Panel Lock can be controlled with an external RS485 device using the KL Command. Changes can be made using the RS 485 Interface or the Auxiliary Current Input (for Emissivity or E-Slope adjustment) when LOCK ON has been selected. The Password is fixed and cannot be changed.

Navigate from TEMP display with ↵ &▲▼to ENGR then use ↵ & ▲▼ to LOCK

Display	Instructions	Display and Limits
LOCK	Press ENT to view Panel Lock state, OFF or ON. Use Up / Down Arrows to enter numerical Password 751. Press ENT. Use Up / Down Arrows to turn Panel Lock OFF or ON. Press ENT to enter and save selection and return to TEMP display.	OFF, ON, 0 to 999

5.6.2 MODL – Sensor Model Number

The MODL function reports the Modline 5 Sensor Model Number as an eight character alphanumeric display. The Sensor Model number is explained in Section 2 Product Description, page 13. The Sensor series, temperature range, optical resolution, and Dirty Widow Detector and Laser Sight options are defined in the Model Number. This information is used during the selection and setup of various functions.

Navigate from TEMP display with ↵ &▲▼to ENGR then use ↵ & ▲▼ to MODL

Display	Instructions	Display and Limits
MODL	Press ENT to view Model. Use Up / Down Arrows to scroll forward and backward through model number shown in the display. Press ENT ↵ to return to TEMP display.	Eight Alphanumeric Character Scroll XX-XXXXXX

5.6.3 F/C – Selection of Fahrenheit or Celsius Indication (°F or °C)

Modline 5 Sensors are specified and delivered in Celsius temperature ranges. The F/C function allows changing the temperature display to indicate in either Celsius or Fahrenheit. The conversion of the Sensor temperature span from Celsius to Fahrenheit follows the formula: F= (1.8 x Celsius) + 32. Example, a 600°C to 1400°C span converts to 1112°F to 2552°F. All outputs and function settings will be in the same units and correspond to the temperature range selected for display. The appropriate °F or °C indicator will be lit for temperature display and setup adjustments when applicable.

After changing the Sensor operation from F to C, or C to F, fine-tuning of the parameters that are related to the F and C measuring units is required. These include: Analog output ZERO and FULL functions in the AOUT Menu; the DR peak picker decay rate and the RBEL reset below temperature functions in the Head Menu.

Navigate from TEMP display with ↵ &▲▼to ENGR then use ↵ & ▲▼ to F/C

Display	Instructions	Display and Limits
F/C	Press ENT to view ºF or ºC selection. Use Up / Down Arrows to change the setup. Press ENT ↵ to save and return to TEMP display.	ºF or ºC

RELY – Alarm Relay Operation

The RELY function configures the operation of the Modline 5 Alarm relay for Normally Open or Normally Closed operation. The Sensor internal relay contacts are available on the Black and Black/White twisted wire pair of the Sensor cable. The Alarm Relay contacts are used to report a Sensor alarm condition.

The sensor self tests its case temperature, detector assembly temperature, output current flow, etc. The Check function checks internal circuit and detector operation. The optional Dirty Window Detector measures the Sensor's window condition. One or more out of limit conditions sensed by these tests triggers an Alarm.

Set the relay operation to correspond to proper and safe use of the contacts in your overall measurement system. Select N C. for closed relay operation with Sensor not in Alarm condition (open in alarm state). Select N.O. for closed relay operation with Sensor in Alarm condition (open when not in alarm condition).

Contacts are open for both N.O. and N.C. operation when the Sensor is not powered, and, for the 3 to 5 seconds after power is applied during the initiate period.

Normally Closed N.C, operation is considered fail-safe operation.

Navigate from TEMP display with ↵ &▲▼to ENGR then use ↵ & ▲▼ to RELY

Display	Instructions	Display and Limits
RELY	Press ENT to view Alarm Relay Operation. Use Up / Down Arrows to select Normally Open, N.O., or Normally Closed, N.C. Press ENT ↵ to save and return to TEMP display.	N.O. or N.C.

5.6.4 CHK – Initiate Manual System Check

→ for 52, 5G, 5R models

The **CHK** and Auto Cal **Hour** functions are different for the Series 56 Models. Separate explanations and instructions are provided for Series 56 Models on the pages that follow.

Refer to the instructions for your Model!

This function checks the Modline 5 Sensor performance by initiating a System Check. When this function is initiated, the Sensor's infrared detector output, internal gain and offset voltages are checked.

The check cycle lasts less than ten seconds. During the Check, the Sensor TEMP display indicates CAL. The Alarm Led indicator and Alarm Relay remain at their last condition. Target temperature measurement is suspended. The Analog Output readings are not derived from real time temperature measurement during Check function. The Analog Output is held at its last output value. Peak Picker, Track and Hold and Response time functions are suspended. At the end of the cycle, operation returns to normal and temperature measurement resumes.

If the Check does not pass, the ALARM Indicator on the Sensor rear panel will light. Press an Up/Down Arrow to view an Error Code on the Display. See Section 7 Maintenance, page 127, for information about alarms and error codes.

Checks can be made manually or scheduled automatically with the HOUR function that follows. Process temperature measurement is interrupted for 5 to 10 seconds during the check period.

After application of power, a warm-up time of approximately 5 to 15 minutes is required for the Sensor's infrared detector and/or electronics. The Sensor Rear Panel Alarm indicator will be lit and Error Code X104 (Detector Cold) displayed when the ▲ arrow is depressed.

The instrument Check function should not be initiated until the Alarm indicator has turned off. An Out of Alarm (X102) may occur if initiated during warm-up. If a X102 Alarm occurs, repeat the Check after warm-up.

On Sensors with firmware Versions 1.08 and higher, the Cal Check function will not operate during Sensor Alarms X107, X106, X105, X104, X103, X101. See Section 5.12 Out of Range Displays and Error Codes, **page 112,** **for error code explanations.**

The Check should not be initiated when a single Alarm or multiple Alarms for Error Codes X103 (Detector block too hot), X104 (Detector block too cold), X105 (Internal case temperature too high), X106 (Internal case temperature too low) are active.

Navigate from TEMP display with ↵ &▲▼to ENGR then use ↵ & ▲▼ to CHK

Display	Instructions	Display and Limits
CHK	Press ENT to initiate Check. Sensor cycles through 10 second check and then returns to the TEMP display.	CAL

5.6.5 HOUR– Automatic System Check

→ for 52, 5G, 5R models

Refer to the instructions for your Model!

The CHK and Auto Cal Hour functions are different for the Series 56 Models. Separate explanations and instructions are provided for Series 56 Models on the pages that follow.

The HOUR function provides for selection of an automatic System Check. This function automatically initiates the check described above. A selection of OFF or a time interval in hours between checks is offered.

A manual Check from the Sensor Keyboard, as explained above, or by RS-485 Communication will start a new period, but not change the value of the interval. This will start a new interval.

Process temperature measurement and control requirements need to be considered when using this automatic function. Real time process temperature measurement and signal conditioning is suspended for up to ten seconds.

Continuous interval setting should be 8 hours or greater. A 168 hour, 1 week, (or greater) automatic interval and manually initiated checks are the recommendations that will provide minimal measurement interruption.

Navigate from TEMP display with ↵ &▲▼to ENGR then use ↵ & ▲▼ to Hour

Display	Instructions	Display and Limits
HOUR	Press ENT to view Automatic Check selection, OFF or numerical value representing hours between Checks. Use Up / Down Arrows to change selection and setting. See above recommendations. Press ENT ↵ to save and return to TEMP display.	OFF or Value 1 to 9999

5.6.6 CHK – Manual System Calibration for 56 Models

This function checks a Model 56 Sensors performance by initiating a System Calibration Check. When this function is initiated, the Sensor's infrared detector signal, internal gain and offset voltages are checked. First, a flag is closed inside of the unit to block the optical path of the instrument. Operation of the Sensor is determined with no target in the field of view of the infrared detector. Second, a calibration source with a known radiance is activated inside the Sensor and the radiance is "seen" by the infrared detector. The response of the sensor electronics to the radiance is compared to an expected value.

If the Calibrate Check determines a Model 56 Sensor requires recalibration, the sensor firmware performs a Self Calibration adjustment. Typically, only small changes in calibration will occur.

During the Calibration Check, the Sensor Rear Panel TEMP display indicates CAL. The Alarm Led indicator and Alarm Relay remain at their last condition. Target temperature measurement is suspended. The Analog Output is held at its last output value. The Analog Output readings are not derived from real time temperature measurement during Calibration Check function. Peak Picker, Track and Hold and Response time functions are suspended. At the end of the cycle, operation returns to normal and real time temperature measurement resumes.

Temperature indications may shift slightly upon return to normal operation.

A Calibrate Check is required for to insure accurate operation of the Series 56 Sensors and should be

performed routinely, every 168 hours or less. The check can be initiated by any of the three methods described below.

Upon Sensor Turn On
If the Sensor has not been powered for 15 minutes or more, a Calibration Check will be performed after the unit is powered and warmed up and stabilized, approximately 15 to 20 minutes after powering on.

Automatically
A Calibrate Check can be initiated every 168 hours using the Sensor Auto Calibrate HOUR function. An OFF setting is also available. If the OFF is selected, Manual Calibrate Checks must be initiated every at least every 168 hours.

Manually
Initiate a Manual Calibrate Check using the Sensor Rear Panel Keypad or Modline 5 accessory. Accessories include the Model DPM Panel Meter, Model MSI multiple sensor interface, ModView software or an RS-485 communication command.

Series 56 Manual and Automatic (HOUR Function) Initiated Calibration Check Summary			
Calibration Check Initiation	**Alarm Condition**	**Display**	**RS485 and 20mA Temperature Outputs**
Manually Initiated Calibration Check with Self Calibration, if required. It is not recommended to perform a Manual check more once than every 24 hours.	Alarms Off Note 1	CAL (Sensor, ModView, DPM, MSI)	Last Temperature reading held
HOUR Parameter (168 Hours or OFF) User Selected Time Interval 168 hours only. (Factory default setting = 168) **OFF** User must perform Manual Cal every 168 hours or less.	Alarms Off Note 1	CAL (Sensor, ModView, DPM, MSI)	Last Temperature reading held

The Calibrate Check function will not operate with Sensor Alarms X107, X106, X105, X104, X103, X101. A Detector Hot or Cold alarm must be off for at least 15 minutes before a Cal Check can be initiated. See Section 5.12 Out of Range Displays and Error Codes, page 112 for error code explanations.

Series 56 Self Calibration at Power On or After Power Interruption of 15 minutes or longer			
Calibration Check Initiation	**Alarm Condition**	**Temperature Display**	**RS485 and 20mA Temperature Outputs**
Sensor is within Operating Temperature Range (0 to 55°C /32 to 131°F)) at Power On	15 minute warm-up and Self Cal cycle time	Detector Hot / Cold Alarms on	Temperature is Displayed and provided at outputs but is not accurate until alarms are off and after Self Cal cycle
At Power On: Sensor is outside Operating Temperature Range (0 to 55°C /32 to 131°F)) but in Storage Temperature range (-20°C to 0°C or 55°C to 65°C / -4 to 32°F or 131 to 149 °F).	Warm-up and Self Cal requires warm-up within Operating Temperature f	Detector Hot / Cold Alarms on	Temperature is Displayed and provided at outputs but is not accurate until alarms are off and after Self Cal cycle
Power Interruption of less than 15 minutes Operation			
Power Interrupt (ON-OFF-On) Off Time Less Than 15 minutes	Fifteen minute warm-up time starts on return to power on. Self Calibration is not Initiated	Detector Hot / Cold Alarms on for 2 minutes	Temperature is Displayed but may not be Accurate Accurate after 2 minutes

Initiate a Manual Cal Check

Navigate from TEMP display with ↵ &▲▼to ENGR then use ↵ & ▲▼ to CHK

Display	Instructions	Display and Limits
CHK	Press ENT to initiate Calibration Check. Sensor cycles through Sensor Check and Self Calibration, if necessary, and then returns to the TEMP display. It is not recommended to perform a Manual check more once than every 24 hours	CAL

If the Check and Self Calibration does not pass, the ALARM Indicator on the Sensor rear panel will light. Press an Up/Down Arrow to view an Error Code on the Display. Multiple arrow entries may be required to view all error codes.. Error Code X102 is an Out of Calibration Alarm. See Section 7 Maintenance, page 127 for information about alarms and error codes.

5.6.7 HOUR– Automatic Calibration Check for 56 Models

Refer to the instructions for your Model!

The HOUR function provides for selection of an automatic System Calibration Check and Self Calibration if needed. This function automatically initiates the calibration check described above.

A Manual or power on Calibration Check will start a new period, but not change the value of the HOUR interval.

Process temperature measurement and control requirements need to be considered when using this

automatic function. Real time process temperature measurement and signal conditioning are suspended for 15 seconds.

RS485 and Current Loop Outputs are held at the last reading during the Self Calibration.

Navigate from TEMP display with ↵ &▲▼to ENGR then use ↵ & ▲▼ to Hour

Display	Instructions	Display and Limits
HOUR	Press ENT to view Automatic Calibration Check. Selection is a numerical value representing hours between a Check with Self Calibration. 168 hours only or OFF Press ENT ↵ to save and return to TEMP display. **If OFF is selected, user must perform Manual Cal every 168 hours or less.**	Value in hours = 168 (Factory setting) or OFF

5.6.8 WRNL – Dirty Window Detector Option Warning Level

The Dirty Window Detector Option is specified at the time the Sensor is ordered and must be factory installed. The WRNL function is only viewed on Sensors with the option. Select OFF, CORS or SENS. OFF turns the dirty window detection off. Coarse and sensitive Warning Levels select a greater (CORS) or lesser (SENS) amount of Sensor window transmission loss required to trigger an alarm.

Navigate from TEMP display with ↵ &▲▼to ENGR then use ↵ & ▲▼ to WRNL

Display	Instructions	Display and Limits
WRNL	Press ENT to view Dirty Window Detector Warning Level selection, OFF, SENS (Sensitive) or CORS (Coarse) Use Up / Down Arrows to select. Press ENT ↵ to save and return to TEMP display.	OFF, CORS, SENS.

5.6.9 VER – Sensor Firmware Version

The VER function reports the Sensors installed firmware version. A four-digit numerical value is displayed. The version information is useful when discussing operation with factory personnel. The firmware cannot be updated in the field.

Navigate from TEMP display with ↵ &▲▼to ENGR then use ↵ & ▲▼ to VER

Display	Instructions	Display and Limits
VER	Press ENT to view Sensor Firmware Version. Press ENT ↵ to return to TEMP display.	Numerical Value XX.XX

5.6.10 iALM – Selects Ratio Invalid Measurement Condition as an Alarm

Selects the Ratio Unit Invalid Measurement Condition as an Alarm.

Alarm and Invalid Condition selection sets both the Error Codes and Invalid Measurement Conditions to operate the Alarm rely and ALARM word on the Sensor rear panel. Invalid Measurement Conditions do not trigger the Alarm relay or the Alarm word with Error Code Alarms Only selected.

Navigate from TEMP display with ↵ &▲▼to ENGR then use ↵ & ▲▼ to iALM

Display	Instructions	Display and Limits
iALM	Press ENT to view Invalid Condition Alarm selection. OFF = Error Code Alarms only (includes the optional Dirty Window Detector alarms) ON = Error Code Alarms and Invalid Condition (INV and pINV) activated as Alarms. This function also turns on the Attenuation Alarm. Use Up / Down Arrows to select. Press ENT ↵ to save and return to TEMP display.	OFF or ON

5.6.11 ATTN – Selects Attenuation Alarm Threshold

Set the percent attenuation alarm threshold. Any attenuation greater than this value will turn on the alarm and also turn on the Dirty Window LED on the back panel. Setting this to 95 will turn this alarm off since that is the invalid threshold. The iALM must be set on in order to enable this alarm.

Navigate from TEMP display with ↵ &▲▼to ENGR then use ↵ & ▲▼ to ATTN

Display	Instructions	Display and Limits
ATTN	Press ENT to view Attenuation Threshold. Use Up / Down Arrows to select. Press ENT ↵ to save and return to TEMP display.	10% - 95%

Background:

With most two-color infrared thermometers, an invalid indication is reached when the reduction in signal from the target is greater than 95 percent. When the signal reduction is too great, an invalid condition occurs. This variation can be caused by emission characteristics of the target or the target being too small to completely resolve, as well as obstructions in the sight path (i.e., certain types of smoke). When an invalid condition occurs, an alarm output is provided to indicate the signal variation is too great between the two detectors. While this type of detection method is suitable for many applications, there are some instances where the user wants to adjust the sensitivity level of attenuation.

The Modline 5 attenuation adjustment alarming feature operates independent from the optional dirty window detector, which will monitor the sensor window for contamination. It enables users to monitor any kind of signal attenuation caused by dirty viewports or other external windows. Attenuation alarm settings are configurable from 5 to 95 percent, from either the back panel of the sensing head or from the Ircon Modview program. When an alarm condition is detected, relay outputs provide notification to external process control instrumentation.

When the attenuation adjustment alarming feature is enabled, the user can monitor attenuation levels in a graphical format in the Modview program providing a historical view of the levels. In addition, attenuation levels are available through the Modline 5 RS-485 output fed into an external device.

5.7 AOUT – Setup of Analog Signal Output Current Range and Temperature Scaling

Modline 5 Sensors provide selection of the analog output current range and scaling of the selected range to temperature. Scaling establishes a temperature span to correspond to the analog output

current range. The span can be equivalent to the Sensor's specified span or narrower. See Section 4 Sensor Wiring, page 62 for detailed information on analog output signals.

This signal is available from the Blue and Blue/White twisted wire pair of the Sensor cable. See Section 4 Sensor Wiring, page 62 for wiring details.

SOUT – Analog Output Current Range Selection
Modline 5 Sensors provide a selection of one of two analog output direct current ranges, 0 to 20 mA or 4 to 20 mA. This function selects the desired range.

ZERO – Analog Output Zero Scale Temperature Scaling
This function sets a temperature to correspond to the selected Analog Output Current Range minimum value (0 or 4 mA). This temperature must be within the Sensor's specified temperature range and is limited to a maximum value equivalent to 10°F (-12.2°C) below the Sensor full scale temperature, or, 10°F (-12.2°C) below the adjusted Analog Output Full Scale temperature value (explained below). Minimum setting is the Sensor specified zero scale temperature. See notes after FULL explanation for ZERO – FULL °C operation and span setting information.

FULL – Analog Output Full Scale Temperature Scaling
Sets a temperature to correspond to the Analog Output Current Range maximum value (20 mA). Temperature must be within the Sensor specified temperature range and is limited to a minimum value 10°F (-12.2°C) above the Sensor's specified zero scale temperature, or, 10F° (-12.2°C) above the adjusted Analog Output Zero Scale temperature value (explained above). Maximum setting is the Sensor specified full scale temperature.

For ZERO – FULL span setting.
°F and °C operation: The minimum 10° span is calculated by the Sensor in °F. When using °C units, the span will be less than 10° because the Sensor first calculates in °F and then converts to °C. The narrower equivalent °C span is allowed.
Spans more than 30°C (60°F) may be required to obtain acceptable results. Longer response times may be necessary for very narrow spans to smooth magnified temperature variations and noise.

5.7.1 Fatl – Analog Output Operation for Sensor or Dirty Window Detector Malfunction Alarms

Sets the Analog Output current to a specified value when unit is in one of two alarm conditions. A Sensor failure (Error Code X107) or Dirty Window Detector operation failure (Error Code X109) will trigger this alarm.

Selectable range is from 0 mA to 24 mA

5.7.2 A–LO – Analog Output Low Temperature Alarm

Sets the Analog Output current value if the measured temperature is below the temperature that produces Analog Zero Scale Output as determined by the Analog Output Zero Scale Temperature Scaling explained above. Selectable range is 0 mA to 4 mA for the 4 to 20 mA current output range.

If the current loop is set for 0 to 20 mA operation, the A–LO function will not appear as a menu item. The analog output always goes to 0 mA if the measured temperature is below the Analog Output Zero Sale temperature.

5.7.3 A–HI – Analog Output High Temperature Alarm

Sets the Analog Output current value if the measured temperature is above the temperature that produces Analog Full Scale Output as determined by the Analog Output Full Scale Temperature Scaling explained above. Selectable range is 20.0 mA to 24.0 mA.

Analog Output Settings

Navigate from TEMP with ↵ &▲▼to AOUT then use ↵ &▲▼ to SOUT or ZERO or FULL or Fatl or A-LO or A-HI

Press ENT ↵ to save and return to TEMP display after each function.

Display	Instructions	Display and Limits
SOUT	Press ENT to view the SOUT output current range, 0 to 20 mA or 4 to 20 mA Use Up / Down Arrows to select output current range.	0-20 or 4-20
ZERO	Press ENT to view temperature corresponding to the selected Analog Output Current Range minimum value (0 or 4 mA) Use Up / Down Arrows to set Temperature within the Sensor temperature range and high limit shown.	Temperature Value Maximum is 10 F below the selected FULL temperature (see below) See note above for °C operation.
FULL	Press ENT to view Temperature Corresponding to the Analog Output Maximum value (20 mA) Use Up / Down Arrows to set Temperature within the Sensor temperature range and low limit shown.	Temperature Value Minimum is 10 F above the selected ZERO temperature (see above) See note above for °C operation.
Fatl	Press ENT to view the Analog Output selected mA current value. Use Up / Down Arrows to set the current value.	00.0 to 24.0
A–LO	This function does not appear if the SOUT selected range is 0 to 20 mA. Press ENT to view the Analog Output selected mA current value. Use Up / Down Arrows to set the current value.	00.0 to 4.00
A–HI	Press ENT to view the Analog Output selected mA current value. Use Up / Down Arrows to set the current value.	20.0 to 24.0

5.8 COMM – Setup of RS-485 Digital Communication Configuration

The Modline 5 RS-485 Digital Communication interface permits interchange of ASCII coded information between the Modline 5 Sensor and a host computer, PLC (Programmable Logic Controller), or any other RS-485 device.

The RS-485 data signal is transmitted on the Yellow and Yellow/White twisted wire pair of the Sensor's interconnecting cable. All communication is via half-duplex two wires.

Refer to Section 6 Digital Communications, page 114 for the complete explanation of the RS-485 Digital Communications operation and commands.

5.8.1 CLCK – Communications Lock

Communications Lock provides for the configuration of the Modline 5 RS-485 Communications. Communication can be configured to allow selection and adjustment of functions in Read and Write

(R / W) operation, or in Read Only (R / O) operation. Read Only operation does not allow external RS-485 devices to change settings in the Sensor.

R / O operation still allows the unit to respond to the RS485 AC Automatic Calibrate Command to initiate a check (CHK) and the PR Peak Picker Reset Command to perform a reset.

5.8.2 ADDR – Sets the Sensor Address

The Unit Address is a one digit number or single letter code. It ranges from a single numeric 0 to 9 to an upper case A to Z. The Address factory-default setting is 0 (zero).

5.8.3 BRAT – Baud Rate

The Sensor Baud Rate must match that of the other RS-485 device. Four baud rates are supported: 9600, 19200, 38400, and 57600 bits of information per second (Baud). The factory setting is 57.6K Baud.

5.8.4 LASR –Laser Operation (Sensor Firmware Versions 1.08 and Higher)

Selects Sensor Rear Panel or RS485 operation only or remote switch operation using the I IN or PkHd functions. See Section 5.11 Laser Sighting Operation, page 110.

RS485 Communication

Navigate from TEMP with ↵ &▲▼to COMM then use ↵ &▲▼ to ADDR or BRAT or CLCK

Press ENT ↵ to save and return to TEMP display after each function.

Display	Instructions	Display and Limits
CLCK	Press ENT to view Communications LOCK. Use Up / Down Arrows to select R / O (Read Only) or R / W (Read and Write) operation.	R / O or R / W
ADDR	Press ENT to view Sensor Address. Use Up / Down Arrows to set to one of thirty-six addresses.	0 to 9 and A to Z
BRAT	Press ENT to view baud rate. Use Up / Down Arrows to select 9600, 19.2K, 38.4K or 57.6K Baud.	9600 or 19.2K or 38.4K or 57.6K
LASR	Press ENT to view Laser operation Selection. Use Up / Down Arrows to select	PANL or I IN or SWIT

5.9 HEAD – Setup of Sensor Operating Functions

The HEAD menus and functions set up the Modline 5 Sensor for process temperature measurement. The initial setup should follow the order given below. It is useful to perform the setup while the Sensor is sighted on the actual target, but not necessary. Preset of the function selections is possible and may be required if the access to the Sensor is not possible or safe conditions to perform adjustments do not exist.

5.9.1 R.T. – Response Time

The Modline 5 Sensor Response Time function provides signal filtering for meaningful temperature information while eliminating unwanted temperature variations. Refer to Section 8 Applications Guide, page 137 for Response Time Application Information. See section 2 Product Description, page

13 for Model specific response time information.

If you determine that your Response Time must be greater than 30 seconds, it is recommend that you trial your process. Long Response Time settings are close approximations and may vary from the selected value.

The Response Time selected affects the temperature signal input to Temperature Display, Analog Output, RS-485 Communications and the Peak Picker and Track and Hold signal conditioning functions.

The Response Time setting for a Ratio Sensor in the two-color ratio mode takes effect under valid measurement conditions. Under Invalid measurement conditions, the Sensor response time is preset for a fast response regardless of the Response Time function setting.

Navigate from TEMP display with ↵ &▲▼to Head then use ↵ &▲▼ to R.T.

Display	Instructions	Display and Limits
R. T.	Press ENT to view Response Time in Seconds. Use Up / Down Arrows to adjust Response Time. Press ENT ↵ to save and return to TEMP display.	0.01 to 60.0 Seconds for * 5R Ratio Sensors
		0.006 to 60.0 Seconds for Series 52 and 5G .006 = 6.6 milliseconds
		0.02 to 60.0 seconds Model 56 Sensors*

5.9.2 COLR – Ratio Unit Operation Selection

The COLR function sets the Modline 5 Ratio Sensor operation in the two color mode for ratio temperature measurement or in the single color mode for brightness temperature measurement.

Navigate from TEMP display with ↵ &▲▼to Head then use ↵ &▲▼ to COLR.

Display	Instructions	Display and Limits
COLR	Press ENT to view Color Selection. Use Up / Down Arrows to select: 1 for single color brightness operation or 2 for two color ratio operation	1 or 2

5.9.3 E-SL – Ratio Unit Two Color Operation E-Slope Adjustment

Ratio Sensors require the correct E-Slope value selection for measuring temperatures of both non-greybody and greybody/blackbody targets. To get a true measure of the temperature you must select the E-Slope values to match the material being measured. The value can be set in "real time" while viewing the process. The adjustable range for this function is 0.800 to 1.200.

- Determine the E-Slope value by referring to Section 8 Applications Guide, page 137 or other reliable source.
- Enter the proper E-Slope value in the E-SL function.

If you change materials or if the material characteristics change, re-determine the E-Slope for the material and readjust the E-SL function if necessary.

If you are viewing your target through a window, consider the effect of window transmission as described in Section 8 Applications Guide**, page 137.**

Navigate from TEMP display with ↵ &▲▼to Head then use ↵ &▲▼ to E-SL.

Display	Instructions	Display and Limits
E-SL	Press ENT to view E-Slope. Use Up / Down Arrows to adjust. Press ENT ↵ to save and return to TEMP display.	0.800 to 1.200

5.9.4 Remote E-Slope Current Input

You may make remote analog adjustments of the E-Slope value by sending a scaled input of 4 to 20 mAdc. This signal is inputted using the Orange and Orange/White twisted wire pair of the Sensor's interconnecting cable. The Modline 5 senses an input and the overrides any rear panel or RS-485 settings of E-Slope or Match. Wiring connection and scaling information are in Section 4 Sensor Wiring, page 62.

5.9.5 EMIS – Emissivity Adjustment for Brightness Sensors

Modline 5 brightness sensors and one color operation of ratio sensors require Emissivity adjustment for accurate temperature measurement. The Emissivity value is set to the characteristics of the material being measured using the EMIS function. Ratio sensors that are using the Attenuation Alarm feature will need to set the sensor to a single color mode, set the correct emissivity for the target, then set the sensor back to 2 color mode (When using the Attenuation Alarm feature, you must set the emissivity and also the e-slope for the sensor)

1. Determine the Emissivity value of your target by referring to the instructions in Section 8 Applications Guide, page 137.
2. Select the proper Emissivity value, from the Tables in Section 8 Applications Guide, page 137 for the surface finish.
3. The adjustable range of the Emissivity is 0.100 to 1.000. See Section 2.3 Model Configuration and Required Selections, page 15 for Emissivity restrictions.

If the material changes characteristics or you change materials, re-determine the Emissivity for the new material and adjust the Emissivity value.

If you are viewing your target through a window, consider the effect of window transmission loss as described in Section 8 Applications Guide, page 137.

Navigate from TEMP display with ↵ &▲▼to Head then use ↵ &▲▼ to EMIS.

Display	Instructions	Display and Limits
EMIS	Press ENT to view Emissivity Value. Use Up / Down Arrows to adjust. Press ENT ↵ to save and return to TEMP display.	0.100 to 1.000

5.9.6 Remote Emissivity Current Input

You may make remote analog adjustments of the Emissivity value by sending a scaled input of 4 to 20 mAdc. This signal is inputted using the Orange and Orange/White twisted wire pair of the Sensor's interconnecting cable. The Modline 5 senses an input and overrides any rear panel or RS-485 settings of Emissivity or Match. Wiring connection and scaling information are in Section 4 Sensor Wiring, page 62.

5.9.7 MTCH – E-Slope or Emissivity Selection Based on Temperature Match

The MTCH function of the Modline 5 Sensor provides for adjusting the E-Slope or Emissivity values

by setting and matching the Sensor's temperature display to the known temperature of a process target.

The Match temperature should be set with a Sensor Response Time of 100 milliseconds or faster. Peak Picker or Track and Hold must be Off. The Match function should be set with stable process temperatures. After setting the Match temperature, the response time, Peak Picker and Track and Hold can be set to the values required for process temperature measurement.

Navigate from TEMP display with ↵ &▲▼to Head then use ↵ &▲▼ to MTCH.

Display	Instructions	Display and Limits
MTCH	While viewing process target, Press ENT to view Match temperature. Use Up / Down Arrows to adjust to the known target temperature. Emissivity or E-Slope, if within allowed limits, will be automatically adjusted for a matching TEMP display. During the adjustment, the Response Time should be set to 100 milliseconds, or faster, and Peak Picker or Track and Hold signal conditioning set to Off. If the resulting Emissivity or E-Slope is not within allowed limits, the Match value cannot be inputted and ERR will be seen on the display after pressing ENT ↵. Return to EMIS or E-SLP to view resulting value if desired.	Temperature in °C or °F XXXX

The MATCH function will not operate during Sensor Alarms X107, X106, X105, X104, X103, X101 or a CAL (CHK). See Section 5.12 Out of Range Displays and Error Codes, page 112, for error code explanations.

5.9.8 SIGL – Signal Conditioning Selection

The Modline 5 Sensor can provide Peak Picking or Track and Hold Signal Conditioning. The SIGL function sets the signal condition to Peak Picker, Track and Hold or Off.

Peak Picker signal conditioning is used to obtain the peak measured temperature value and ignore momentary decreases in measured temperature. This eliminates erratic measurements due to gaps in work pieces, bursts of smoke, or steam, or other intermittent interferences in the sight path of the Sensor. Signal conditioning affects all displays and outputs.

Track and Hold signal conditioning is used to track process temperature when required and then hold the temperature measurement at some point in time as determined by the process requirements. This eliminates erratic measurements due to process measurement delays or other undesired measurement periods.

Peak Picker and the Track and Hold signal conditioning functions are explained in Section 8 Applications Guide, page 137.

Peak Picker PSEL Functions

Peak Picker Signal Conditioning selection activates the PSEL Peak Function menu. This menu is used to adjust Peak Picker functions necessary for obtaining the peak measured temperature value. These functions must be adjusted to match the process for proper operation.

External Switch Control of Track and Hold Operation

The Modline 5 has provisions for a remote process controlled input switch be wired to the Violet and Violet/White twisted wire pair of the Sensor's interconnecting cable. If Track and Hold signal conditioning is selected, the switch input is required to change from Track temperature operation (switch open) to Hold mode (switch closed) as required in the process system.

Wiring and switch operation for the Track and Hold feature are described in Section 4 Sensor Wiring, page 62.

Navigate from TEMP display with ↵ &▲▼to Head then use ↵ &▲▼ to SIGL.

Display	Instructions	Display and Limits
SIGL	Use Up / Down Arrows to select OFF / PEAK / TRAK Note: – Use external control switch to operate Track and Hold modes. – Adjust PSEL Parameters if Peak Picker selected. – Use external control switch for remote Peak Picker reset and operation. Press ENT ↵ to save and return to TEMP display.	OFF = No Signal Conditioning TRAK = Track and Hold PEAK = Peak Picker

5.10 PSEL – Peak Picker Functions

The PSEL Functions are for Peak Picker Operation. Refer to Section 8 Applications Guide, page 137 for a description of Peak Picker signal conditioning operation including these functions

5.10.1 D.R. – Decay Rate Function

The Decay Rate range is 0.00 to 300.00°F or 0.00 to 166.66°C per second depending on Fahrenheit or Celsius units selection. The Decay Rate must be set to retain peak measured temperature value and ignore momentary decreases in measured temperature caused by process conditions. The goal is to eliminate erratic measurements due to gaps in work pieces, bursts of smoke, or steam, etc. in the sight path of the Sensor while allowing the peaked value to decay down to lower process temperature values as they occur.

Sensor Firmware Version Operation Summary
Original Sensors with firmware versions less than 1.02 have unit-less degree units that range 0.00 to 300.00 for both F and C units selection. The instructions provided on the next page are for Sensors with firmware versions 1.02 and higher.

DPM – Digital Panel Meter Interface firmware version operation:

For DPM Interfaces with firmware versions 1.2 used with Sensor firmware version less than 1.02.
Sensor set for °C, DPM will read, but not enter values higher than 166. Sensor can be set to 300.
Sensor set for °F, DPM and Sensor are compatible.

For DPM Interfaces with firmware versions 1.1 used with Sensor firmware 1.02 and higher:
Sensor set for °C, DPM will read or enter values to 300. Sensor can be set to 166.66 maximum.
Sensor set for °F, DPM and Sensor are compatible.

5.10.2 RSET – Manual Peak Picker Reset

Performs a manual Peak Picker reset. The Peak Picker Reset "clears" the stored peak information. The Sensor begins to measure temperature in the Peak Picker mode again after a manual reset.

5.10.3 External Switch For Remote Peak Picker Reset

The Modline 5 has provisions for a remote process controlled input switch to be wired to the Violet and Violet/White twisted wire pair of the Sensor's interconnecting cable. If Peak Picker signal conditioning is selected, the remote switch can enable or disable the Peaking action. With no switch

or the switch maintained in the open position, Peaking action is enabled. With the switch closed, peaking action is disabled and the Sensor continuously indicates actual temperature variations as they occur.

A momentary closure of the switch resets the Peak Picker function to the current temperature reading. The peaking action begins again when the switch returns to the open position.

Wiring and switch operation for the Peak Picker are described in Section 4 Sensor Wiring, page 62.

5.10.4 AUTO – Auto Peak Picker Reset

With Peak Picker On, the Auto Peak Picker Reset function will cause a Reset when the measured temperature matches or is below the selected Reset Below temperature. As long as the measured and displayed temperature remains below the selected temperature, the Peak Picker remains in reset condition and the Sensor continuously measures and indicates temperature without any peaking picking action.

This function is affected by the Response Time function. It is possible for a long response time to delay a Reset triggered by the Reset Below temperature even though the target temperature has decreased.

5.10.5 RBEL – Reset Below Temperature

Automatic Peak Picker Reset must be on for this function to appear in the menu. Sets the Reset Below Temperature that causes Automatic Peak Picker Reset with the Peak Picker On and Auto Peak Picker Reset On. When the target temperature matches or is below the selected value, Automatic Peak Picker Reset will take place and the Sensor indicates temperature without any peaking action.

5.10.6 DEL – Peak Picker Delay

Peak Picker signal conditioning may be delayed. The Peak Picker Delay time is selectable in the range of 0.01 to 10.00 seconds. Its primary use is with the Auto Peak Picker Reset and Reset Below Temperature functions. The Peak Picker Delay function is used to delay the start of the peaking action for up to 10 seconds following the detection of the leading edge of a new target. See Section 8 Applications Guide, page 137 for a detailed explanation.

It has limited operation when used with Peak Picker signal conditioning without the Auto Peak Picker Reset function. It will provide the selected delay after any Peak Picker Reset. The reset can be from the Sensor rear panel, a reset from a momentary closure of the Peak Picker Reset external switch or a reset from the RS485 PR command.

Navigate from TEMP display with ↵ &▲▼to Head then use ↵ &▲▼ to PSEL, then use ↵ & ▲▼ to D.R. or RSET or AUTO or RBEL or DEL.

Press ENT ↵ to save and return to TEMP display after each function.

Display	Instructions	Display and Limits
PSEL	Use Up / Down Arrows to select D.R. or RSET or AUTO or RBEL or DEL Then press ENT to view, select and adjust Function.	D.R. or RSET or AUTO or RBEL or DEL
D.R.	Instructions for Sensors with firmware versions 1.02 and higher. Press ENT to view and then use UP / Down Arrows to adjust Decay Rate will is in degrees per second depending on the measuring units selected.	0.00 to 166.66 (°C Sensor) Or 0.00 to 300.00 (°F Sensor)
RSET	Press ENT to trigger Manual Peak Picker Reset. Display will automatically return to TEMP.	
AUTO	Press ENT to view. Use Up / Down Arrows to select Auto Peak Picker Reset operation ON or OFF	ON, OFF
RBEL	Press ENT to view. Use Up / Down Arrows to set Reset Below Temperature within Sensor's specified temperature Range.	Numerical Value XXXX Temperature in ºC or ºF
DEL	Press ENT to view. Use Up / Down Arrows to Select Off or set Peak Picker Signal Conditioning Delay in seconds.	OFF or 0 .01 to 10.00

5.11 Laser Sighting Operation

The Laser Sighting Option is specified at the time the Sensor is ordered and must be factory installed. A pushbutton labeled LASER is supplied on the rear panel to energize the laser. The pushbutton is located in the center of the rear panel in place of the visible sight. Press the LASER pushbutton once to energize the laser, press the pushbutton once again to de-energize the laser. A red LED located above the pushbutton is illuminated when the laser is energized. The Laser also can be operated remotely using a switch. See Section 5.8 COMM – Setup of RS-485 Digital Communication Configuration, page 103 for selecting remote switch operation. See next page for operating instructions.

The Laser will not energize during the CHK or the MATCH function. In addition, if the Laser is energized and a manual (CHK function) or automatic (HOUR function) system check or MATCH Function is initiated, the Laser will turn off.

Refer to Section 3.3.3 Laser Sight, page 24. for information on using the Laser to aim and focus the Sensor.

Before turning on the Laser remotely with the DPM Digital Panel Meter Interface or other devices using RS– 485 Communications, or a remote switch, insure there are no personnel in the path of the beam.

Display	Instructions	Display and Limits
Manual Pushbutton	Normal Rear Panel Operation. See next page for Remote Switch Operation: Under safe operating conditions, Momentarily depress LASER pushbutton to energize the Class 2 Laser. Press pushbutton again to de-energize. Laser will automatically turn off after 20 minutes if not de-energized.	LED above LASER Button Lights

Remote Laser Operation (Sensor Firmware Versions 1.08 and Higher)

Remote operation is selected from the COMMS – LASR Menu. The operation for PANL, I IN and SWIT modes of operation are explained below.

COMM Menu LASR Mode Selection	Sensor Rear Panel LASER Switch	RS-485 LS Command (ModView, DPM, MSI)	Peak/Hold Switch (Remote SPST Switch Required)	I – IN Current Input (Remote SPST Switch Required)
PANL **Operation**	Energizes and turns Laser Off.	Energizes and turns Laser Off.	Not Enabled for Laser Operation.	Not Enabled for Laser Operation.
I IN **Remote Current Input Operation**	Can de-energize Laser anytime. Can Energize Laser. Condition Set One applies.	Can de-energize Laser anytime. Can Energize Laser. Condition Set One applies.	Not Enabled for Laser Operation in I IN mode.	15 mADC input current (Switch Closed) energizes Laser. Current disconnected (Switch open) de-energizes laser. Condition Set One applies
SWIT **Remote Pk/Hd Switch Operation**	Can de-energize Laser anytime. Can Energize Laser. Condition Set Two applies.	Can de-energize Laser anytime. Can Energize Laser. Condition Set Two applies.	PkHd Switch operates Laser. Condition Set Two applies.	Not Enabled for Laser Operation in SWIT mode

Laser I IN Operation

When Laser I IN operation is selected, remote current input of Emissivity and E-Slope is not operational. The required SPST switch can be an actual toggle or a press and hold type switch that

would de-energize the laser when released. See Section 4.9 Connecting Device Cables to POI Box or Terminal Strip Plate, page 73 for resistor, DC Voltage selection and circuit wiring.

I IN Operation - Condition Set One

1.A If Sensor is powered up with I IN current applied (remote switch closed), the Laser will not operate until the remote switch is opened and then closed again. The Laser will only operate with switch closed.

1.B When the Laser is energized by closing the remote switch, the laser can be de-energized with a RS-485 Command, the Rear Panel Laser Switch or by disconnecting I IN current (remote switch open). If none of these occur, the Laser de-energizes after the 20 minute time out period.

1.C If Laser has been de-energized by a RS485 Command, the Rear Panel Laser Switch or the 20 minute timeout period, the I-In current must be disconnected (switch open) and re-applied (switch closed) to energize the Laser with the remote switch. However, the laser can be activated with the Sensor Rear Panel Laser switch or RS485 command without opening and closing the switch.

1.D The Laser can be energized by the Rear Panel Laser Switch or a RS485 command only when the remote switch is closed and condition 1A has been satisfied.

PkHd Switch Operation

When Laser PkHd switch operation is selected, remote switch Reset of the peak picker, and, the Track and Hold function are not operational. The SPST switch can be an actual toggle or a press and hold type switch which would de-energize the laser when released. The Peak Picker can be reset at the Sensor Rear or with a RS-485 command.

Condition Set Two

2.A If Sensor is powered up with the PkHd switch closed, the Laser will not operate until the switch is opened and then closed again. Laser will only operate with PkHd switch closed.

2.B When the Laser is energized with a PkHd switch closure, the laser can be de-energized with the Rear Panel Laser Switch, a RS-485 Command, or by opening the PkHd switch. If none of these occur, the Laser de-energizes after the 20 minute time out period.

2.C If the Laser has been de-energized by a RS485 Command, the Rear Panel Laser Switch or the 20 minute timeout period, the PkHd switch must be opened then closed to energize the Laser with the PkHd switch. However, the laser can be activated with the Rear Panel or RS485 command without opening and closing the switch.

2.D The Laser can be energized by the Rear Panel Laser Switch or a RS485 command only when the PkHd switch is closed and condition 2.A has been met.

PkHd Switch wiring.

The switch is wired directly across the PkHd Switch terminals on the POI Power Supply/Signal Interface Box or the TSP Terminal Strip Plate. See Section 4.9 Connecting Device Cables to POI Box or Terminal Strip Plate, page 73 for switch wiring.

5.12 Out of Range Displays and Error Codes

The Modline 5 displays word messages on its rear panel display to indicate Sensor diagnostic results. Below are explanations of the reported measurement status and error codes.

Measurement status displays for Out of Range and Invalid measurement conditions are defined as follows:

LOW Conditions do not allow measurement because the infrared temperature signal is too low.
The target temperature is too low for the range of the Sensor.

HIGH Conditions do not allow measurement because the infrared temperature signal is too high.
The target temperature is too high for the range of the Sensor.

INV Measurement Conditions are invalid for two color ratio temperature measurement.
When the Invalid Alarm (iALM) function is set to ON, this measurement condition becomes an alarm and triggers the Alarm relay and the ALARM word on the Sensor rear panel. **If INV is the only Alarm, pressing the ▲ pushbuttons will show no other Error Codes.**

The above conditions may relate to improper installation or adjustment of Sensor Functions. Avoid reflections from surrounding hot objects, unresolved targets, and obstructions in the Sensor's optical path. True temperature measurement is dependent on correct setting of Emissivity or E-Slope.
Use of Pick Picker or Track and Hold signal conditioning may be necessary to capture temperature signals because of process interferences.

The Rear Panel ALARM indicator signals an error as been detected. Press Up Arrow ▲ to view Error Codes. **Press Up Arrow ▲ multiple times to view all simultaneous Error Codes.**

Error Codes for Sensor diagnostic information are summarized as follows:

X101 Dirty Window Detection

X102 Out of calibration

X103 Detector block too hot

X104 Detector block too cold

X105 Internal Case temperature too high

X106 Internal Case temperature too low

X107 Sensor failure. FAIL may be seen on the Sensor TEMP display

X108 Analog Output Current loop malfunction

X109 Dirty Window Detection malfunction

pINV pINV is only displayed when the Invalid Alarm (iALM) function is set to ON and Peak Picker or Track and Hold is On. This condition becomes an alarm and triggers the Alarm relay and the ALARM word on the Sensor rear panel.

Temperature displayed is Peak Picked or Hold Mode Temperature values from prior valid measurement conditions.

Environmental conditions can cause Sensor errors. High or low ambient temperatures can cause Sensor case temperature too high or too low errors. Dirty lens conditions can be avoided using air purging.

See Section 7 Maintenance, page 127 for possible causes of problems and troubleshooting.

Investigate all alarms indicated by the ALARM word indicator. Temperature readings on rear panel display, at Analog Output or from RS-485 Communications may be inaccurate with Error Codes X101 through X109 alarms.
Ratio Temperature measurement conditions are invalid with INV and pINV alarms.

5.12.1 Summary

The initial setup procedure is complete and the Sensor should provide accurate display of the process temperature. Auxiliary equipment connected to outputs will respond to the measured temperature.

1. The system should measure process temperatures viewed by the Sensor. Response to changes in temperature will depend on the Response Time, Peak Picker or Track and Hold Signal Conditioning Functions.
2. During start-up routines, observe measured temperature closely to insure proper measurement. If necessary, fine-tune Sensor operating functions. Refer to Section 8 Applications Guide, page 137 for applications and measurement information.
3. Allow the proper amount of time for the display to settle when making measurements. Settling time depends on the Response Time selected. Response time also affects the analog outputs and when the sensor is used as input to a closed loop control system consideration should be given to the effects of response time.
4. Investigate Alarms and Error Codes to determine if there are installation problems or Sensor malfunctions.
5. The Sensor rear screw on protective window must be in place during temperature measurement to maintain the NEMA 4 (IP65) Sensor housing rating and protect the keyboard and internal parts from contamination.

6 Digital Communications

6.1 RS-485 Digital Communications

6.1.1 Introduction

The MODLINE 5 Sensor permits RS-485 digital signal interchange of ASCII coded information with a host computer, PLC (Programmable Logic Controller), or any other RS-485 device. The external device can obtain information from the Sensor and modify Sensor settings.

Be thoroughly familiar with operation of the sensor as explained in Section 5 Operation, page 90 of this manual!

The Yellow and Yellow/White twisted wire pair of the standard Sensor interconnecting cable carries the signal .See Section 4 Sensor Wiring, page 62 of this manual for wiring, termination and use of extension cables.

6.1.2 Basic Operation

The RS-485 Digital Communications interface allows an external device to communicate with the

Sensor by sending messages it can understand. Any messages the Sensor sends back will also be in its own "language". The messages are based on a list of commands described in this section. Any values included in the messages are in decimal and bit mapped values.

Whenever there is a need to change a Sensor parameter or to obtain information from the Sensor, the external device must send a properly coded and formatted message. If there is any error, the Sensor will ignore the message. In turn, when the Sensor transmits information back to your external device, the response message will be in the same standard message format. The external device must be able to interpret the response message.

Command Codes are the part of the message that request work (change values, etc.) to be done by the Sensor. Commands that request work are "Write" commands. The same codes used Read commands request the Sensor to report the status of the work. Command Codes are listed later in this section. All except one of the command codes can be used as Read commands to obtain the current status of functions and readings. Many commands are Write compatible and are used to change settings.

Read request command messages sent from the external RS-485 device cause the Sensor to automatically send back a status message. For example, if the external device (host/PLC) sends a read command to the Sensor to report the Emissivity value, the Sensor sends a response message containing the current Emissivity setting.

Write command messages sent by an external device include value or other information. These messages will cause a change of Sensor parameters. The Sensor replies with a status message.

Note: Writing new values into the unit will cause it to stop updating the temperature the temperature for up to 200 milliseconds.

6.2 Sensor Rear Panel Setup for RS-485 Communication

The following Sensor RS-485 Communication attributes must be correctly selected at the Sensor Rear Panel for communications to take place. RS-485 Commands for these functions are not provided. The instructions are in manual Section 5 Operation, page 90 for these functions.

6.2.1 CLCK – Communications Lock

Communications Lock provides for the configuration of the Modline 5 RS-485 Communications. Communication can be configured to allow selection and adjustment of functions for Read and Write (R / W) operation or Read Only (R / O) operation. Read Only operation causes write commands sent to the Sensor to be turned into Read Commands.

R / O operation does allow the RS485 AC Automatic Calibrate Command to initiate a CHK and the PR Peak Picker Reset Command to perform a reset.

6.2.2 ADDR – Sets the Sensor Address

The Unit Address is a one digit number or single letter code. It ranges from a single numeric 0 to 9 to and upper case A to Z. The Address factory default setting is 0 (zero).

6.2.3 BRAT – Baud Rate

The Sensor Baud Rate must match that of the other RS-485 device. Four baud rates are supported: 9600, 19200, 38400, and 57600 bits of information per second.

6.3 Communication Protocol

Communication is half-duplex, two wire. The Sensor does not support simultaneous transmit and receive. Four baud rates are supported: 9600, 19200, 38400, and 57600 bits of information per second. All characters are ASCII 7 bits, even parity, 1 stop. Commands have a response. Another command should not be sent until a response has been completely received. There is a 1-millisecond minimum delay between receipt of command and response. The maximum delay is less than 200 milliseconds.

6.3.1 Command Message Format

All command messages have the same format:
<Start Bit> <Sensor Address> <Channel Number> <Command Code> [<Value>] <Carriage Return>

Example: #A0CCXXXXX<CR> Where:

Start Bit = #	*Always the pound sign character.*
Sensor Address = A	*A single alphanumeric character address of the Sensor, 0 to 9, A to Z* *0 (zero) is the factory-default setting. The wild card address of ' ? ' is accepted by the MODLINE 5 regardless of its set address. Do not use the "?" address if more than one Sensor is connected.*
Channel Number = 0	*Is always the 0 (zero) character.* *This one-digit entry value is not used in the MODLINE 5. SET to 0 (zero) for future use.*
Command Code = CC	*Is one of the two alpha character command codes from the list below.* *All the commands are detailed below.*
Value = XXXXX	*Is the value included with a Write message and reported in the Sensor reply. The range of acceptable input value is given for each command code. If the value is omitted, execution of the instruction will return* the present value *of the parameter involved. If a value is included, execution of the instruction will store the specified value to in the Sensor's non-volatile memory.*
Carriage return = <CR>	*All messages are concluded with ASCII code CR, "Enter" on computer keyboard.*

6.4 Command Codes

6.4.1 Introduction

The Command Codes allow operation and setup of the Modline 5 Sensor similar to the Rear Panel pushbuttons. Refer to the manual section referenced for configuration and operation information as directed for each code.

The Command Codes have been separated into four categories as follows:

- Engineering Functions
- Analog Output Functions
- Head Functions
- Measurement Conditions and Alarms

If the command is fully recognized, the command will be echoed back as "#A0CCXXXXX<CR>", where XXXXX will be the value sent if the command sent parameters that changed something, or the

current setting, if no parameters were sent. If the parameters sent are out of range or otherwise not allowed, the current setting will be returned.

The message format must be correct for the sensor to reply. If the "#A0" is followed by any number of characters and a carriage return character is not received, the unit will not respond at all. If at least a fragment of the command is received, but the command code is not recognized, a response of "#a0cc?HUH?" will be returned.

6.5 Engineering Function Command Codes

KL – Keyboard Lock (Read / Write)

Locks or unlocks the Sensor's rear panel keyboard. When the keyboard is locked, all functions work and can be viewed, but not changed, at the Sensor. The keyboard can also be locked and unlocked from the Sensor rear panel. RS-485 Write commands are not locked out with this command.

Range: 0 or 1 (0 = Unlocked; 1 = locked)

MD – Model Number (Read Only)

Returns the Model number of the Sensor.

Value: An eight character Model Number is returned.

UN – Units Select (Read / Write) See Section 5.6 ENGR – Setup of Engineering Functions, page 94 for important information when changing units.

Sets the temperature units the Sensor uses for measurement and display.

Range: 0 to 1 (0 = Fahrenheit) (1 = Celsius)

UZ – Unit Zero Scale (Read Only)

Returns the Sensor's zero scale temperature as defined its Model Number. An F or C is put on the end as appropriate.

UF – Unit Full Scale (Read Only)

Returns the unit's full-scale temperature as defined by its Model Number. An F or C is put on the end as appropriate.

AC – Auto and Immediate Calibration Initiate (Read / Write) For 52, 5G, and 5R models.

See next paragraph for Models begging with 56. See Section 5.5 Warm-up and Initial Setup, page 93.

Sets the number of hours between Systems Checks. A manual Check from the Sensor Keyboard or by RS-485 Communication will start a new time period. Continuous interval setting should be 8 hours or greater. A 168 hour, 1 week, (or greater) automatic interval and manually initiated checks are the recommendations that will provide minimal measurement interruption.

Range: 0 to 9999, 65535

A zero value disables this function. Values between 1 to 9999 sets the time period in hours.

A value of 65535 ($FFFF_{16}$) causes an immediate Check to occur without changing the previously set time period value.

AC – Auto and Immediate Calibration Initiate (Read / Write) For Models begging with 56.

Series 56 Models include a Self Calibration feature performed as part of the power on routine. Explanation of this feature is provided in Section 5.5 Warm-up and Initial Setup, page 93, under the explanations for sensor parameters: CHK - (Models Beginning with 56) and HOUR - (Models Beginning with 56).

Range: 0 or 168, 65535

A zero value disables this function (a Manual Initiation must be performed at least every 168 hours).
A value of 168 sets the time period between calibration checks to 168 hours (Factory setting)
A value of 65535 ($FFFF_{16}$) causes an immediate Calibration to occur without changing the previously set time period value. This is equivalent to a Manual Calibration at the Sensor Rear Panel.

RP – Relay Polarity (Read / Write)
Sets the polarity of the alarm relay. Set to 1 for "fail safe" operation. Contacts are held open with power off or power on and in the brief warm-up state for either polarity.
Range: 0 or 1 (0 = N.O; to 1 = N.C.)

DT – Dirty Window Detector Warning Level (Read / Write)
This command is available only with the Dirty Window Detector option.
This command is the same as the Sensor Rear Panel WRNL. OFF turns the dirty window detection function off. Course and Sensitive Warning Levels select a greater (CORS) or lesser (SENS) amount of Sensor window transmission loss required to trigger a dirty window alarm.
Range: 0 to 2
Message Value:
0 = Dirty Window Detection Alarm Off
1 = Sensitive (SENS)
2 = Coarse (CORS)

SW – Switch Input Status (Read Only)
Command Returns the Sensor's external switch status (Peak Picker reset and Hold mode select).
Range: 0 or 1 (0 = closed; 1 = open)

BT – Report Isoblock Temperature (Read Only)
Returns the infrared detector isoblock temperature in °C.
Typical Value Range: 0 to 65

RC – Instrument Temperature (Read Only)
Returns the unit's internal case temperature in °F or °C.
Range: N/A
Expected value is within the Range: 0 to 65 °C.

VR – Firmware Version (Read Only)
The VR command returns the Sensor's firmware version number in the format: VV.RR. VV is the major version number, RR is the revision number.
Range: N/A

TP – Controller Type (Read Only) – Reserved for future use.
Always returns zero.
Range: Not Applicable

LS – Laser Control
Command is available with Laser sighting option only. Turns the sighting laser on or off. Note that the laser has an automatic timeout of twenty minutes.
Range: 0 or 1
Values: Turns on the laser (1) or turns off the laser (0).
The Laser will not energize during the System Check. Also, if the Laser is energized and a manual (CHK function) or automatic (HOUR function) system check is initiated, the Laser will turn off.

Observe and follow cautions below and operating instructions in Section 5.11 Laser Sighting Operation, page 110 of this Modline 5 Manual.

Before turning on the Laser remotely with the DPM Digital Panel Meter Interface or other devices using RS– 485 Communications, insure there are no personnel in the path of the beam.

FT – Features Matrix (Read Only)

Returns the features that this unit supports.

Note: When bits 1 and 2 are not set, Sensor is 52 Series Brightness Unit. Range: N/A

Bit Values:

Two color detector (R-series)	0x0001	1
LASER pointer	0x0002	2
Dirty window detector	0x0004	4
G-series	0x0008	8
Transfer Standard	0x0010	16
Unit is chopped	0x0020	32
Unit has TEC	0x0040	64

Ignoring LASER, DWD and Transfer Standard:

5R-series = 1

52-series = 0

5G-series = 8

56-series = 96 (60Hex)

57-series = 32 (20_{Hex})

SN – Sensor Unit Serial Number (Read Only)

Range: N/A

Message Value: Returns the serial number string of the unit.

RR – Alarm Operation (Read / Write)

Command is only available with Series 5R ratio units. When this is turned on, it also enables the Attenuation alarm.

AT – Attenuation Alarm Threshold (Read / Write)

Set the percent attenuation alarm threshold. Any attenuation greater than this value will turn on the alarm and also turn on the dirty window LED on the back panel. Setting this to 95 will turn this

alarm off since that is the invalid threshold. The relay response (see command RR) must be set on in order to enable this alarm

6.6 Analog Output Function Command Codes

AO – Analog Output Current Range (Read / Write)

Sets the Analog Output Current loop range to either 0 to 20 mA or 4-20 mA
Range: 0 or 1 (0 = 4 to 20 mA; 1 = 0 to 20 mA)

AZ – Analog Zero Scale (Read / Write)

Analog Zero Scale command specifies the measured temperature that will produce the Analog Output Zero Scale current. See Section 5.7 AOUT – Setup of Analog Signal Output Current Range and Temperature Scaling, page 101 about minimum spans and °F / °C operation.
Message Value Range: Sensor's zero scale temperature to 10°F below its full scale temperature.
The Sensor's selected measurement units, "F" or "C", are ignored in the Write command. Sensor Reply Returns with an "F" or "C" to show which units are selected.

AF – Analog Full Scale (Read / Write)

Analog Full Scale command specifies the measured temperature that will produce the Analog Output full scale current. See Section 5.7 AOUT – Setup of Analog Signal Output Current Range and Temperature Scaling, page 101 about minimum spans and °F / °C operation.
Message Value Range: Sensor's zero scale temperature + 10° to its full scale temperature.
The Sensor selected measurement units, "F" or "C", are ignored in the Write command. Sensor Reply Returns with an "F" or "C" to indicate which units are selected.

AA - Analog Output Alarm (Read / Write)

Sets the Analog Output current to a specified value when unit is in any of two alarm conditions. A Sensor failure (Error Code X107) or Dirty Window Detector circuit failure (Error Code X109) will trigger this alarm.
Scaled Message Value Range: 0 to 240
Actual Range 0.0 mA to 24.0 mA

AL – Analog Output Low Temperature (Read / Write)

This command is used to set the value of the current loop output as an alarm if the measured temperature is below the scaled or default temperature that produces Analog Zero Scale Output current.
Scaled Message Value Range: 0 to 40
Actual Range is 0.0 mA to 4.0 mA for the 4 to 20 mA current output range.

If the current loop is set for 0 to 20 mA operation, the AL command setting is overridden and the analog output always goes to 0 mA if below zero scale temperature.

AH – Analog Output High Temperature (Read / Write)

This command is used to set the value of the current loop output as an alarm if the measured temperature is above the scaled or default temperature that produces Analog Full Scale Output current.
Scaled Message Value Range: 200-240
Actual Range: 20.0 mA to 24.0 mA

6.7 Head Function Command Codes

CL – Select Mode of Ratio Sensor Operation (Read / Write)

Command is for 5R ratio units only. The CL command selects One Color or Two Color operation for a Series 5R ratio Sensor.

Message Value Range: 1 or 2 (1 selects single color brightness mode; 2 selects two color ratio mode).

RT - Response Time (Read / Write)

Sets the Sensor Response Time.

Scaled Message Value Range: 0 to 6000

(Scaled value = actual value times 100 above Sensor minimum Response Time limit)

Range for Series 52 or 5G Sensors: 0 (Minimum) to 6000 (60 Seconds)

(Zero = somewhat less than .006 second; Zero = not valid for 5R, 56 Sensors)

Range for Series 5R Sensors: 10 (.01 second) minimum to 6000 (60 Seconds)

Range for Series 56 Sensors: 20 (.02 second) minimum to 6000 (60 Seconds)

ES – E-Slope (Read / Write)

Command is for 5R ratio units only. Sets the E-Slope for Ratio Sensors operating in the 2 color ratio mode. Function is not active for single color mode.

If the Sensor's remote scaled E-Slope input current is active, the Sensor returns that setting ignoring any ES Write command or Rear Panel keyboard entry.

Scaled Message Value Range: 800 to 1200 (Scaled value = actual value times 1000)

Actual Range: .8 to 1.2

EM – Emissivity (Read / Write)

Sets Emissivity for single color units or Ratio units in 1 color mode. If the Sensor's remote scaled Emissivity input current is active, Sensor returns that setting ignoring any EM write command or Rear Panel keyboard entry.

Scaled Message Value Range 100 to 1000 (Scaled value = actual value times 1000)

Actual Range: .01 to 1.0

MT – **Match** Temperature (Read / Write)

Alternative method of selecting the value for Emissivity or E-Slope. The Write Message Value is the known temperature of the target the Sensor is measuring. The unit will change Emissivity (single color units) or E-Slope (two-color ratio units) to a value to that produces a displayed temperature equivalent to the target temperature. The Sensor returns the required Emissivity, or E-Slope value, if the result is in range. If the unit is unable to match the temperature then the return value is "ERR".

The Match temperature should be set with a Sensor Response Time of 100 milliseconds or faster. Peak Picker or Track and Hold must be Off. The Match function should be set with stable process temperatures. After setting the Match temperature, the Response Time, Peak Picker and Track and Hold can be set to the values required for process temperature measurement.

Write Message Range: Unit's zero scale to full scale temperature

Reply Message Value: Emissivity or E-Slope value or ERR

TT – Temperature (Read Only)

Returns the temperature the unit is reading in the current units. An F or C is put on the end as appropriate. The temperature resolution is 1°F or °C.

Message Value Range: From the low end to the high end of the Sensor temperature range.

Some special readings are:

-32768(8000_{16}) – Sensor Failure
-32512(8100_{16}) – Unit not warmed up.
-32256(8200_{16}) – Invalid
-32000(8300_{16}) – Temperature too low, below Sensors range
-31744(8400_{16}) – Temperature too high, above Sensor range

TO – Temperature Only (Read Only) (Sensor firmware Versions 1.07 and higher)

Returns the temperature the unit is reading in the current units. An F or C is put on the end as appropriate. The temperature resolution is 1°F or °C.

Message Value Range: This command only reports values that are within the Sensors temperature range. Actual reported values are from approximately three degrees below the low end of the Sensor temperature range to approximately three degrees above the high end of the Sensor temperature range. Values below zero scale or above full scale are not accurate and should not be used.

There are no special readings to indicate that the temperature is out of range (too high or too low) or invalid. Use the ST Status command to sense the temperature TO Value is under range (below the sensor zero scale temperature) or the TO value is over range (above the full scale temperature) or Invalid for ratio measurements.

SG – Signal Conditioning Usage (Read Only)

Turns Peak Picker or Track and Hold on and off. Only one can be turned on at time.
Range: 0 to 2
Message Values:
0 – Peak picker and track & hold are both off.
1 – Peak picker on.
2 – Track & Hold on.

PR - Peak Picker Reset (Write Only)

This function is used to reset the Peak Picker. It is a write only command and no value is given. By sending the PR Command, with or without a message value, a Peak Picker reset is performed.
Message Value Range: Not Applicable
Actual value: Always returns #A0PR<CR>, where A =the sensor

DR – Peak Picker (Read / Write)

Sets the peak picker decay rate. Zero (0) sets the unit to never decay. Otherwise decay is in selected measurement units, °F or °C. See Section 5.10.1 D.R. – Decay Rate Function, page 108 for more information.
For Sensors with firmware versions 1.02 and higher
Scaled Message Value Range: 0 to 30000 (°F per second times 100)
Scaled Message Value Range: 0 to 16666 (°C per second times 100)
Actual Value: .01 to 300.00 (°F per second), except 0 which = Off
Actual Value: .01 to 166.66 (°C per second), except 0 which = Off

Sensor Firmware Version Operation Summary
Original Sensors with firmware versions less than 1.02 have unit-less degree units that range 0.00 to 300.00 for both F and C units selection. For those Sensors, the following operation applies.
Sets the peak picker decay rate. Zero (0) sets the unit to never decay. Otherwise decay is in °F or °C per second.

Scaled Message Value Range: 0 to 30000 (°F or °C per second times 100).

PS – Peak Picker Auto Reset (Read / Write)
Selects Peak Picker Auto Reset operation
Scaled Message Value Range: 0 to 2
Actual Value: .0 to 2: Zero (0) Sets Auto Reset to Off: 1sets it to On. (2 is reserved for future use).

PK –Peak Picker Reset Below Temperature (Read / Write)
Sets the temperature below which the peak picker signal conditioning is in reset or direct reading mode. Sensor is measuring temperature without peaking action in this mode. Function is used with Auto Peak Picker Reset.
Message Value Range: Unit's Zero Scale Temperature to Unit's Full Scale Temperature (°F or °C)

PD –- Peak Delay (Read / Write)
Sets the delay time before Peak Picker action starts.
Message Value Range: 0 to 1000 – Zero (0) turns off any delay. Above 0, this is a scaled value. (Scaled input above 0 = actual value times 100).
Actual Delay Range in Seconds: 0.010 to 10 seconds.

6.8 Measurement Condition and Alarm Command Codes

6.8.1 Introduction

This section identifies measurement and alarm status commands and defines the reported errors and measurement conditions.

TI – TS – Temperature, Status, and Attenuation (Read Only)
Returns the temperature the unit is reading, followed by a comma, then the current status (see the ST command for details), another comma, and then the current attenuation percent (expressed as a number from 0 to 100)
Range: N/A

TS – TS – Temperature and Status (Read Only)
Returns the temperature the unit is reading followed by a comma, and then either a 0 (no alarm conditions), or a number with the same format as the "ST" Command.
Range: measured temperature in degrees C or F and –32768 to 32767.

ST - System Alarm and Measurement Condition Status (Read Only)
The Sensor returns a message indicating the current measurement condition status and the status of alarms.
Range: Not Applicable
Values: Bit mapped values for alarm and measurement status.

Value	Condition	Equivalent Display or Error Code
0	None to Report	None
1	Out of calibration	Same as Error Code X102
2	Signal invalid (may not be set in Peak Picker mode)	Invalid 1 Same as INV on rear panel
4	Case temperature too low	Same as Error Code X106
8	Case temperature too high	Same as Error Code X105

16	Detector block cold	Same as Error Code X104
32	Detector block hot	Same as Error Code X103
64	Current loop fault	Same as Error Code X108
128	Dirty window detection	Same as Error Code X101
256	Sensor failure	Same as Error Code X107 or FAIL on rear panel display
512	DWD failure	Same as Error Code X109
1024	Signal invalid (Always set regardless of Peak Picker mode). Measured Signal too low for ratio measurement, Displayed Temperature is Peak Picked or Hold mode Temperature	Invalid 2 Same as Error Code pINV on rear panel display when Alarm button pushed
2048	RS485 Communications Lock	RS485 Communications Locked out, In read only
4096	Temperature reading under range	Same as LOW on rear panel TEMP display
8192	Temperature reading over range	Same as HIGH on rear panel TEMP display
16384	Laser pointer is on	Same as Laser LED on Sensor rear panel
–32768	Unit under Cal test	Same as CAL on rear panel TEMP display

6.9 Command Code Summary

Code	Command Description	Type	Group	Notes
AA	Analog alarm output	R/W	Analog Out	Sets the Analog Output to a specified value when unit is in any of two alarm conditions. (Error Codes X107, X109).
AC	Auto cal time period (in hours)	R/W	Eng.	Sets the number of hours between Automatic Checks or performs immediate check.
AF	Analog full scale	R/W	Analog Out	Analog Full Scale command specifies the measured temperature that will produce the Analog Output full scale current.
AH	Analog output high temperature alarm	R/W	Analog Out	Sets alarm condition at the Analog Output if the measured temperature is above the value for Analog Full Scale Output.
AL	Analog output low temperature alarm	R/W	Analog Out	Sets alarm condition at the Analog Output if the measured temperature is below the value for Analog Zero Scale Output.
AO	Analog output mode	R/W	Analog Out	Sets the Analog Output Current loop range to either 0 to 4 mA or 4-20 mA.
AT	Attenuation Alarm threshold	R/W	Eng.	Set the percentage value for the attenuation alarm threshold.
AZ	analog zero scale	R/W	Analog Out	Sets the measured temperature that produces the Analog Output Zero Scale current.
BT	Report Isoblock temperature	R/O	Eng.	Returns the infrared detector isoblock environment temperature in °C.
CL	Set to 1 or 2 color mode	R/W	Head	Selects One Color or Two Color operation for a Series 5r ratio Sensor.
DR	Peak picker decay rate	R/W	Head	Sets the peak picker decay rate in F or C. Zero (0) sets the unit to never decay.
DT	dirty window threshold	R/W	Eng.	Dirty Window Detector Sensitivity Warning Setting
EM	Emissivity	R/W	Head	Sets Emissivity for single color or ratio units in one color mode
ES	E slope	R/W	Head	Sets the E-Slope for Ratio Sensors in the 2 color ratio mode
FT	Features Matrix	R/O	Eng.	Returns bit values for the features the Sensor supports.
KL	Keyboard lock	R/W	Eng	Locks or unlocks the Sensor's rear panel keyboard.
LS	Laser Control	R/W	Eng	Turns the sighting laser on or off.
MD	Model	R/O	Eng	Returns the Model number of the Sensor.
MT	Match Temp Display	R/W	Head	Writes temperature value to be displayed to match target. Read replies Emissivity or E-Slope value
PD	Peak delay	R/W	Head	Sets the delay time before Peak Picker action starts.
PK	peak picker reset below	R/W	Head	Sets the temperature at which Peak Picker action starts with Auto Peak Picker Reset Function
PR	Peak and reset	write	Head	Write Only Command, Resets the Peak Picker
PS	Peak picker auto reset	R/W	Head	Selects Peak Picker Auto Reset operation
RC	Case temperature	R/O	Eng	Returns Sensor's internal Case temperature.
RP	Relay polarity	R/W	Eng	Sets the polarity of the alarm relay.
RR	Alarm Operation	R/W	Eng	When this is turned on, it also enables the attenuation alarm.
RT	Response time	R/W	Head	Sets the Sensor Response Time.
SG	Signal Conditioning	R/W	Head	Turns Peak Picker or Track and Hold on or off.
SN	Serial Number	R/O	Eng.	Returns the serial number string of the unit.
ST	System alarm status	R/O	Alarm	Sensor returns bit mapped values for alarms and the current measurement condition status.

Digital Communications

Code	Command Description	Type	Group	Notes
SW	Switch input status	R/O	Head	Returns the Sensor's external Peak Picker reset and Hold mode select switch status.
TI	Temperature, status and attenuation	R/O	Head	Returns the temperature, current status and the current attenuation percentage.
TO	Temperature Only	R/O	Head	Returns the temperature the unit is reading. No alarm or special values are reported for over range and under range conditions.
TP	Controller type	R/O	Eng.	Reserved for future use. Always returns 0.
TS	Temperature and Status	R/O	Alarm.	Returns the temperature the unit is reading and the Presence of an alarm.
TT	Temperature	R/O	Head	Returns the temperature the unit is reading in the current units (F or C) Special bit mapping messages for measurement status.
UF	Unit full scale	R/O	Eng.	Returns unit's full-scale temperature as defined by Model No.
UN	Units select	R/W	Eng.	Sets the units the Sensor uses for measurement (F or C).
UZ	Unit zero scale	R/O	Eng.	Returns Sensor's zero scale temperature as defined Model No.
VR	Firmware version	R/O	Eng.	Returns the Sensor's firmware version number

7 Maintenance

7.1 Routine Maintenance

7.1.1 Maintenance Checklist

The Modline 5 Sensor is a precision temperature measuring instrument built for rugged service and ease of operation.

When installed and maintained with reasonable care, it will give you reliable service in a wide variety of applications. Routine Maintenance is essential for reliable, trouble-free operation. It consists of a thorough inspection at regular intervals to keep the instrument working efficiently and to head off problems before they occur.

Most "service problems" are caused by incorrect function setup, improper Sensor sighting and focusing, dirty optics, and over heating of the sensor and other conditions that can be found and corrected by a maintenance program.

The following checklist will help you develop a maintenance routine suitable for your installation:

- Perform Sensor Check (CHK) as instructed under Engineering functions menu for Sensor setup in Section 5 Operation, page 90.
- Check Sensor function settings. A record of the correct settings for process being measured should be made.
- Check Sensor for proper alignment and focus. Make sure there are no obstructions in the optical path between Sensor and target. Process viewing windows should be clean.
- Check Sensor lens and clean if necessary. Refer to cleaning instructions below.
- Make sure Sensor is not overheated. If water cooling and/or air purge accessories are used, make sure there is adequate flow of cooling water and clean, dry air.
- Check Sensor interconnecting cable for any signs of mechanical damage or overheating. Make sure all connections are secure.

7.2 Sensor Optics Cleaning

Inspect the standard Sensor lens or the front window and mirror on the Sensor with the Dirty Window Detector option on a routine schedule. Clean these optics of any dust or residue that may have accumulated. If this requires removing the Sensor from its mounting, make sure you note the mounting alignment and lens focus position so you will be able to restore the Sensor to its correct operating position. Always verify focusing as instructed in Section 3 Sensor Installation, page 22.

If the Sensor includes the Laser aiming option, see the Laser option cautions on Section 2.3 Model Configuration and Required Selections, page 15 and Section 5 Operation, page 90.

Protect the Sensor interconnecting cable plug pins from liquids and dirt if disconnected from the Sensor.

Clean the front surface of the lens, or window and mirror as often as necessary. The frequency of the lens cleaning will depend on the environment at the point of installation. Air purging will reduce the necessity of frequent cleaning in dusty, dirty areas.

Treat the Modline 5 Sensor optics with care.

Scratches or harmful solvents can destroy the lens or the Dirty Window Detector window and mirror. Lenses may be slightly soluble in water and other liquids. Do not soak any lens in water or any other liquid for long periods of time.

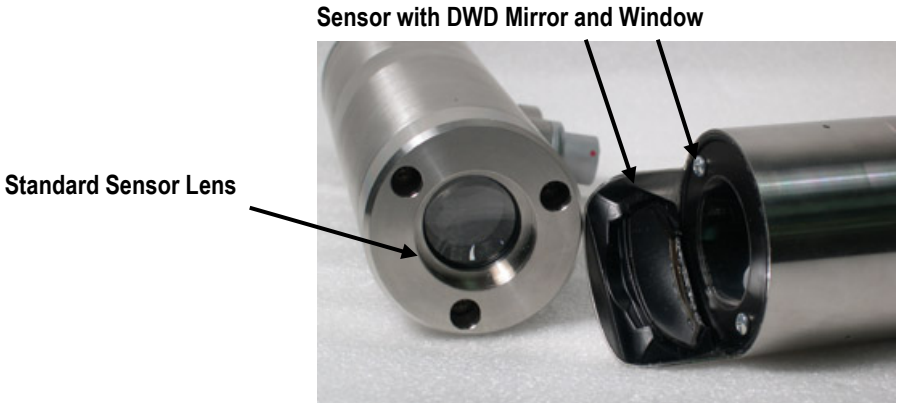


Figure 85: Sensor optics

7.2.1 Cleaning the Optics

Clean the front surface of the Standard lens, or Sensor with DWD window and mirror as often as necessary. Use a soft dry cotton cloth or swab moistened with laboratory grade isopropyl alcohol. Wipe gently to remove residue. Inspect and re-wipe as necessary to remove any film.

7.2.2 Restoring the Sensor to Operation

Always re-install the Sensor in its original position. Always verify focusing as instructed in section 3 Sensor Installation, page 22. Lock the lens by tightening the lens locking screw on the bottom of the unit with your fingers and thumb. Never use a tool.

Place the rear protection window on the back of the Sensor and perform any operational checks that may be necessary to make sure the instrument is functioning properly.

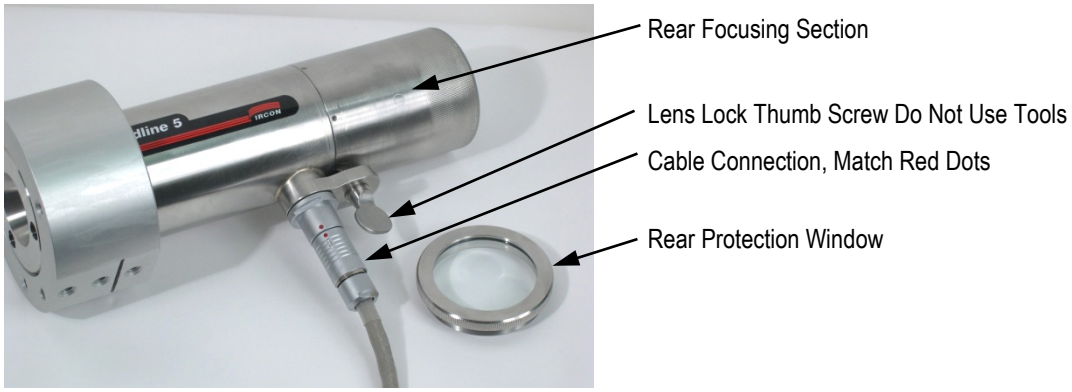


Figure 86

For Modline 56 sensors: occasionally, a calibration flag that operates during the Sensor internal Calibrate test may move into the viewing area during shipment. If this occurs, the viewing area will be dark and appear obstructed. This flag will be positioned correctly when power is applied to the Sensor.

The Modline 5 Sensor with Laser sighting option is a Class II Laser product. When restoring a Sensor with this option back to service, follow the Cautions outlined below and the operating instructions in Section 5.11 Laser Sighting Operation, page 110 of this manual.

Before turning on the Laser remotely with the DPM Digital Panel Meter Interface or other devices using RS– 485 Communications, insure there are no personnel in the path of the beam.

7.3 Servicing

There are no user adjustable controls or serviceable parts within the Sensor Housing. Units must be returned to the factory for calibration and adjustments. Do not disassemble the unit!

7.4 Factory Calibration and Service

Instruments are calibrated against precision laboratory standards and are "burned in" for before shipment to ensure accurate temperature measurements throughout the operating range. To preserve this accuracy, each instrument should be recalibrated periodically on a Blackbody standard. We recommend recalibration of this type on a yearly basis. There are the following methods of calibrating IRCON Modline 5 units:

- You can have your instruments calibrated at our Service Center. An available option is calibration traceable to the National Institute of Standards and Technology (NIST).
- Field Service Agreements geared to your requirements are also available. Options include periodic maintenance (with provisions for guaranteed emergency service rates) and field maintenance with emergency service and parts replacement.
- Using the Modview Calibration software (not available for M56). This software is for sale and allows you to calibrate the Modline 52, 5G, and 5R as long as the calibration does not require a change of more than 30% of the range. You basically need a black body and while the instrument is aimed at the black body you allow the software to set the calibration of the

instrument. You only do one set point with the software but you can make as many checks as you want.

- The fourth method is to use a sensor that is titled a transfer standard. This is a Modline 5, usually the same model as the customers equipment and it is specially calibrated at 10 specific points on the temperature scale of the instrument. A NIST certificate of calibration is furnished with the instrument. With the transfer standard you also get the Modview calibration software. You aim the transfer standard at the black body and read and record the temperature that is indicated on the transfer standard. By using the transfer standard you eliminate any potential errors that may have occurred in the black body such as a defective thermocouple or an inaccurate cavity. Next, you take the instrument to be calibrated and aim it at the black body and with the software install the corrected calibration temperature. Again it is a one point calibration but you can check as many points as you want to insure the best accuracy.

7.5 Measurement Condition Displays, Error Codes and Troubleshooting

The Modline 5 displays word messages on its rear panel display to indicate Sensor diagnostic results. Below are explanations of the reported measurement status and error codes.

Measurement status displays for Out of Range and Invalid measurement conditions are defined as follows

LOW.	Conditions do not allow measurement because the infrared temperature signal is too low. The target temperature is too low for the range of the Sensor.
HIGH	Conditions do not allow measurement because the infrared temperature signal is too high. The target temperature is too high for the range of the Sensor.
INV	Measurement Conditions are invalid for two color ratio temperature measurement. When the Invalid Alarm (iALM) function is set to ON, this measurement condition becomes an alarm and triggers the Alarm relay and the ALARM word on the Sensor rear panel. **If INV is the only Alarm, pressing the ▲ pushbuttons will show no other Error Codes.**

The above conditions may relate to improper installation or adjustment of Sensor Functions. Avoid reflections from surrounding hot objects, unresolved targets, and obstructions in the Sensor's optical path. True temperature measurement is dependent on correct setting of Emissivity or E-Slope. Use of Pick Picker or Track and Hold signal conditioning may be necessary to capture temperature signals because of process interferences.

The Rear Panel ALARM indicator signals an error as been detected. Press Up Arrow ▲ to view Error Codes. **Press Up Arrow ▲ multiple times to view all simultaneous Error Codes.**

Error Codes for Sensor diagnostic information are summarized as follows:

X101 Dirty Window Detection (or attenuation alarm if using a 5R series with the Attenuation Alarm turned on)

X102 Out of calibration

X103 Detector block too hot

X104 Detector block too cold

X105 Sensor internal Case temperature too high

X106 Sensor internal case temperature too low

X107 Sensor failure: FAIL may be seen on the Sensor TEMP display

X108 Analog Output Current loop malfunction (open circuit)

X109 Dirty Window Detection malfunction

pINV pINV is only displayed when the Invalid Alarm (iALM) function is set to ON and Peak Picker or Track and Hold is On. This condition becomes an alarm and triggers the Alarm relay and the ALARM word on the Sensor rear panel.

Temperature displayed is Peak Picked or Hold Mode Temperature values from prior valid measurement conditions.

Environmental conditions can cause Sensor errors. High or low ambient temperatures can cause Sensor case temperature too high or too low errors. Dirty lens conditions can be avoided using air purging.

Investigate all alarms indicated by the ALARM word indicator. Temperature readings on rear panel display, at Analog Output or from RS-485 Communications may be inaccurate with Error Codes X101 through X109 alarms.

Ratio Temperature measurement conditions are invalid with INV and pINV alarms.

7.6 Status Displays and Error Code Details

Status Display	Error Code Details
The temperature display is **LOW or HIGH** Is the Emissivity or E-Slope setting correct? Is the field of view blocked? Are reflections or background energy causing high readings?	• The display shows LOW when the measured temperature is below the Sensor Zero Scale Temperature by a few degrees. • The display shows HIGH when the measured temperature is above the Sensor Full Scale value by a few degrees. • The display remains LOW or HGH as long as the measured temperature is out-of-range.
For Sensor Series 5R Temperature Display is **INV** Note: iALM must be set to ON for this Alarm condition to be displayed on Sensor rear panel and for the Alarm Relay to operate.	• This is an Invalid Alarm display. The process measurement conditions are invalid. The infrared energy reaching the Sensor is too low to provide reliable temperature measurement.
For Sensor Series 5R Alarm condition is **pINV** Note: iALM must be set to ON for this Alarm condition to be displayed on Sensor rear panel and the Alarm Relay operate.	• This is an Invalid Alarm with the Peak Picker On. It is displayed, if the infrared energy reaching the Sensor is too low to provide reliable temperature measurements. • Displayed temperature readings are peaked values or hold values from Peak Picker or Track and Hold signal conditioning.

Status Display	Error Code Details
Error Code **X101** Dirty Window Detected	• Dirty front Sensor optics detected. Clean Sensor front window and mirror. This will only be seen on Sensors with the Dirty Window Detector Option
Error Code **X102** Out of calibration (M56) Do not Initiate a Calibration Check during warm-up. See Section 5.5 Warm-up and Initial Setup, page 93, for M52, 5G, and 5R models.	• Calibration check has sensed Sensor out of calibration condition • Note: An out of calibration error may be encountered if the Sensor temperature is too high or too low. Do not calibrate when an Alarms for error codes X103, X104, X105, X106 exist. • Caution: Any temperature readings at Analog Output or from RS-485 Communications must be considered inaccurate • Check Sensor Calibration on a Blackbody Standard
Error Code **X103** Detector block too hot	• Detector Temperature is too high. • Check ambient temperature (55 °C maximum) and Sensor internal case temperature using the RS485 RC Command or with a temperature measuring device such as a fine thermocouple. If these temperatures are okay and alarm continues Sensor may have a malfunction. • Caution: Any temperature readings on rear panel display, at Analog Output or from RS-485 Communications may be inaccurate.
Error Code **X104** Detector block too cold Note: This Error Code is normal during Sensor warm-up. Warm-up typically lasts from just a few minutes to 15 minutes.	• Detector Temperature is too low • Check ambient temperature (0°C minimum) and Sensor internal case temperature using the RS485 RC Command or with a temperature measuring device such as a thermocouple. • If these temperatures are okay and alarm continue, check the 24VDC supply voltage. Sensor may have a long warm-up time if the voltage not within 5%. • If the power supply is remotely installed, insure the voltage drop across power supply wires is not causing a low voltage level at the Sensor. • Caution: Any temperature readings on rear panel display, at Analog Output or from RS-485 Communications may be inaccurate.
Error Code **X105** Case temperature too high	• Sensor case temperature is below is above specification. • Check ambient temperature (55 °C maximum) and Sensor internal case temperature using the RS485 RC Command or with a temperature measuring device such as a thermocouple. If these temperatures are okay and alarm continues Sensor may have a malfunction. • Caution: Any temperature readings on rear panel display, at Analog Output or from RS-485 Communications may be inaccurate

Status Display	Error Code Details
Error Code **X106** Case temperature too low	• Sensor case temperature is below is below specification. • Check ambient temperature and Sensor internal case temperature using the RS485 RC Command or with a temperature measuring device such as a thermocouple. If these temperatures are okay and alarm continues Sensor may have a malfunction. • Caution: Any temperature readings on rear panel display, at Analog Output or from RS-485 Communications may be inaccurate
Error Code **X107** Sensor failure FAIL may be seen on the Sensor TEMP display.	• Serious problem with Sensor operation exists • Caution: Any temperature readings at Analog Output or from RS-485 Communications must be considered inaccurate. • Replace Sensor
Error Code **X108** Analog Output Current loop malfunction. Analog Output current not correct value Caution: Inaccurate temperature readings may be displayed or used by external devices connected to Analog Output.	• Sensor has sensed external analog output current flow is not accurate. Note: this Error Code only will be seen for errors detected when output current is greater than 0 mA. • Connected devices should have differential inputs; neither input terminal should be grounded. • Check cables and external devices. • See symptom number three in Troubleshooting Table below. • If analog output is not used, place a jumper wire across the output terminals to prevent the X108 alarm from occurring.
Error Code **X109** Malfunction of Sensor Dirty Window Detection.	• Dirty Window circuit operation malfunction. • Replace Sensor

7.6.1 Troubleshooting

If troubles develop in the initial installation or after periods of normal operation, these troubleshooting suggestions may help to identify certain trouble symptoms and possibly correct the problem. If trouble persists, call or contact IRCON Technical Services for help.

Symptom	Possible Cause / Corrective Action
Symptom Number One: **Completely inoperative** • No display of any kind. • No RS-485 Communications • No Analog Output	1. Check 24 Vdc Sensor power supply 2. Check AC line voltage supply connections on power supply 3. Check any line fuse, switch or circuit breaker for power supply. 4. Inspect interconnecting cable and connections for damage. Replace Cable if problem found. 5. Replace Sensor.
Symptom Number Two: **Incorrect Temperature Indications** • No temperature indication or incorrect temperature indication. (Target temperature known to be within system temperature range.) • Under-range (LOW) or Over-range (HIGH) indication displayed. • For Sensor Series 5R Ratio series instruments. Invalid (INV or pINV) indication displayed.	1. Sensor warmed up. See Section 5.5 Warm-up and Initial Setup, page 93. 2. Check Sensor sighting and focusing. Is target resolved? 3. Check for obstruction in sight path. 4. Check for background interference (reflections) causing high temperature readings. 5. Check lens and clean if necessary. (If system includes window or mirror, check and clean.) 6. Check ambient temperature of Sensor. If water cooling is used, make sure coolant is flowing at recommended rate. 7. Check all control settings, particularly Emissivity or E-Slope for Series 8. Perform Calibration Check. (M56)
Symptom Number Three: **No Analog Output, or incorrect Output** • Accurate temperature displayed on rear panel. • RS-485 Communications temperature output okay.	1. Check wiring between the analog output terminals and external devices. 2. Device inputs should be differential type and not grounded. 3. Make sure device is connected and adjusted correctly, and is compatible with Modline 5 specifications. 4. Check grounding of external devices. Improper grounding could prevent proper signals at external devices. 5. Check Analog output Zero and Full Scale Adjustment. 6. Check F / C measurement units selection of Sensor and external device to make sure they are compatible. 7. Series resistance of all devices and cable pairs on Analog Output should not exceed 600 Ohms.

Symptom	Possible Cause / Corrective Action
Symptom Number Four **Erratic temperature display and outputs.** • Target and measurement conditions unknown. Actual temperature variations may sensed.	1. Check for recurrent interruptions in sight path e.g. bursts of smoke or steam, moving equipment. 2. Use air purge to clear some obstructions, If using air purge check air flow and operation 3. Vary the Response Time to see if the symptom changes. 4. Use Peak Picker signal conditioning with suitable decay rate. 5. Use Track and Hold signal conditioning.
Symptom Number Five **Erratic display and outputs.** • Target temperature and measurement conditions known to be stable	1. Check Sensor cable connections. Also, check the signal cable shield connection at the Grounded Strain Relief Fitting. 2. Check for proper grounding of all system components. 3. Check cable routing. Signal cables must not run in the same conduit as noisy power lines or power lines with transients. 4. Check ambient temperature of Sensor Add water cooling and/or heat shielding to Sensor, if necessary.
No Invalid Measurement Condition Alarm	1. Check iALM function under Engineering Menu.
Cannot adjust or select functions at the Sensor rear panel.	1. Check Panel Lock function in Engineering Menu.
RS-485 Communications problems	1. Check Communications Lock setting in COMMS Menu. Selections are Read Only and Read / Write. 2. Check Baud Rate setting in COMMS Menu. 3. Check Address setting in COMMS Menu.
Laser will not energize	1. Laser will not energize when CAL function is operating or initiated
Peak Picker signal conditioning not functioning	1. Check if the Auto Peak Picker Reset is On. If ON, evaluate the Reset Below Temperature settings. Peak Picker may be Auto reset with Reset Below temperature too low
Peak Picker Delay not operating	1. Peak Picker Delay only operates after a Peak Picker Reset or after the first temperature indication displayed after an Invalid (INV) condition or below Sensor temperature range (LOW) condition. 2. Delay timing starts immediately after the reset or the Invalid or LOW condition.
Can not adjust AOUT ZERO or FULL Scale	1. Check both ZERO and FULL settings. Minimum 10°F span is required (or equivalent °C span values)

8 Applications Guide

8.1 Introduction

This section offers guidelines to assure measurement accuracy and reliability. Although it is impossible to cover every application in detail, the general information provided can be adapted to most situations. If you run into other situations that may cause problems, consult the IRCON Applications Engineering Department.

8.2 Analog Outputs

All Modline 5 Sensors provide an analog current signal output of 0 to 20 mAdc or 4 to 20 mAdc. The output range is selected using the Sensors rear panel AOUT and SOUT function menus or RS-485 Digital Communications command codes. This current output will drive remote current meters, recorders and other devices calibrated to read dc milliamps and scaled to convert the analog signals to temperature. Multiple devices (Loads) can be connected in a series current loop configuration. The maximum series resistance that can be connected in the loop is 600 Ohms. This maximum includes the resistance of all devices and cables. See Figure 87.

The minus side of the Analog Output is connected to power supply common (See Section 4.12 RS-485 Multi-Drop Network Power Supply and System Wiring, page 82 of this manual about Sensor Grounding). Use instruments with ungrounded differential inputs. If instruments with grounded inputs are connected in the loop, the output may be inoperable or inaccurate.

If the Analog output is not used, insert a jumper wire across the output terminals. This will prevent an Analog Loop malfunction (open circuit) Alarm (Error X108) from occurring.

The current signal varies linearly with the measured temperature. There are several schemes for temperature scaling these outputs current. The standard scaling is when the output zero scale current and full scale current is scaled to equal the Sensor's zero scale and full temperatures. Alternate temperature scaling can be accomplished using the Sensor's AOUT Main Menu the ZERO and FULL functions. See Section 5 Operation, page 90 of this manual for instructions. The paragraphs and diagram below provide further explanation.

The ZERO function sets a temperature to correspond to the selected Analog Output Current Range minimum value (0 or 4 mA). This temperature must be within the Sensor's specified temperature range and is limited to a maximum value 10° below the Sensor's specified full scale temperature. Minimum setting is the Sensors' specified zero scale temperature.

The FULL Sets a temperature to correspond to the Analog Output Current Range maximum value (20 mA). Temperature must be within the Sensor specified temperature range and is limited to a minimum value 10° above the Sensors' specified zero scale temperature. Maximum setting is the Sensor's specified full scale temperature.

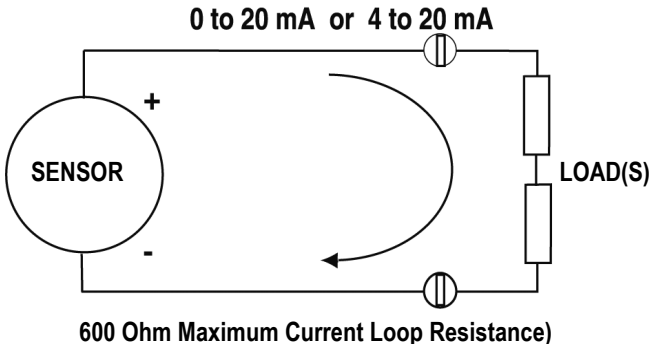


Figure 87: Analog Output Configuration

8.2.1 Analog Output Range Scaling Example

The Sensor temperature range example shown in Figure 88 is 500 degrees to 2500 degrees. The minimum analog output, at 0 or 4 milliamps as selected, can be set to equal the Sensor's 500 degree zero scale temperature or to an alternate value, such as the 1000 degrees illustrated in the figure. The maximum analog output, 20 milliamps, can be set to equal the Sensor's 2500 degree full scale temperature or to an alternate value, such as the 1800 degrees illustrated in the figure.

When scaled to equal the Sensor's complete range, the analog current output corresponds to a 500 to 2500 degree range and a temperature span of 2000 degrees. With the alternate temperature scaling, the analog current output corresponds to a 1000 to 1800 degree range and a temperature span of 1000 degrees.

A minimum 10 degree F (6 degree C) span between zero scale and full scale is required.

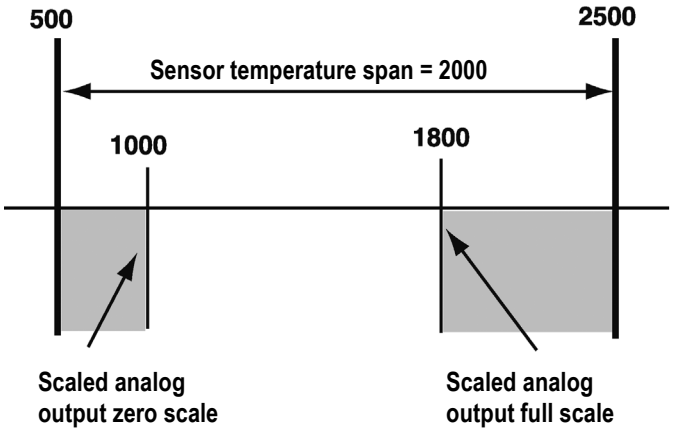


Figure 88: Analog Output Scaling

8.2.2 Measured Temperature Calculations

An analog current signal output of 0 to 20 mA provides a full 20 mA current span. The 4 to 20 mA output provides a 16 mA current span. To convert the output current to temperature, you must know the current output span and corresponding temperature span to calculate the resultant temperature.

Zero current output (0 or 4 mA), as selected, equals the corresponding zero scale temperature. A 20 mA reading corresponds to the full scale temperature. Since the output current varies linearly with temperature, equal increments in current will provide equal increments in temperature between these range limits.

Expressed as a formula for the 4-20 mA analog output is:

$T_{IND} = (((I - 4) / 16) X (T_{F.S.} - T_{Z.S.})) + T_{Z.S.}$

Expressed as a formula for the 0 -20 mA analog output is:

$T_{IND} = ((I / 20) X (T_{F.S.} - T_{Z.S.})) + T_{Z.S.}$

Where I is the current loop output in milliamps, $T_{F.S.}$ is the corresponding full scale temperature and $T_{Z.S.}$ is the Zero Scale Temperature,

Example: For a 4-20 mA analog output, with a 16 mA span, corresponding to the 500 to 2500 degree range and an output current of 8 mA:

$T_{IND} = (((8 - 4) / 16) X (2500 - 500)) + 500 = 1000$ *degrees*

Example: For a 0-20 mA analog output, with a 20 mA span, corresponding to the 800 to 1800 degree range and an output current of 8 ma:

$T_{IND} = ((8 / 20) X (1800 - 800)) + 800 = 1200$ *degrees*

8.2.3 Analog Output Operation Notes

1. The Analog Signal Output is affected by the selected Response Time Value and by any Peak Picker or Track and Hold signal conditioning selections.
2. Three Analog Output related alarm functions can be used to set the Analog Current Output to a specified value for certain conditions. A–LO, A–HI and FATL alarm functions will force the current output to specific values for Zero Scale, Full Scale and two alarm conditions (Sensor failure and Dirty Window Detector operation Failure). See Section 5 Operation, page 90 of this manual for setup instructions.
3. A 10 Volt d.c. full scale signal can be developed by shunting the analog current output with a precision 500 ohm resistor. See Section 4 Sensor Wiring, page 62 of this manual for more information.

8.3 Response Time

8.3.1 Description

Response Time is the length of time it takes for the displayed temperature, the analog current output signal, and digital output to reach approximately 95% of a step change in measured temperature.

The Response Time in the Modline 5 Sensor has an adjustable range from 6.6 or 10 milliseconds minimum, depending on Model, to 60 seconds Maximum. See section 2 Product Description, page 13 of this manual for Response Time restrictions by Model. The Response time can be set using the HEAD menu RT function and RS-485 Digital Communications.

If you find that process temperature variations or signal noise is interfering with your measurement or control system, increase the Response Time as required.

8.3.2 Determining Response Time to Use

The Response Time is factory set for the fastest response time allowed for its Model. You may wish to select a slower response time that is more suitable for the process.

To follow temperature variations as they occur, select a fast response time. If you prefer to "filter out" temperature variations, select a slower response time. In most applications, the practical approach is to observe the temperature display or analog current output and adjust the response time for the most meaningful temperature information without distracting variations. Observe the temperature indications on a Temperature Display, or chart recorder. Figure 89 illustrates the general effects of response times as if plotted by a chart recorder.

The combination of low target temperature and fast response time will cause unstable temperature indications. When measuring low target temperatures, adjust the Response Time slowly to obtain stable temperature readings. Measurements below 400°F (200°C) may require a response time of one second or more. A Response Time setting of 30 milliseconds usually provides good starting point for higher process temperatures.

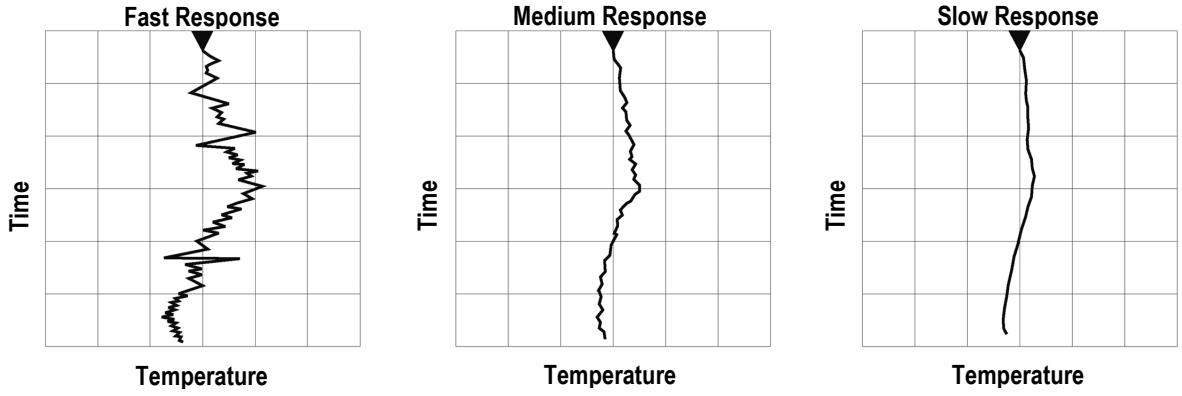

Fast Response
Time
Temperature
Medium Response
Time
Temperature
Slow Response
Time
Temperature
Temperatur display and output signals follow temperature variations as fast as minimum response time of instrument.
Rapid temperature variations are “filtered out“ and system follows general trends in temperature, with small amounts of “ripple“.
Sensor tracks slow variations in temperature ans effects of temperature spikes are eliminated.

Figure 89: Effects of Response Time

8.4 Emissivity Settings

An ideal infrared radiator, called a *blackbody*, emits the maximum amount of infrared energy possible at a given temperature. It has an Emissivity (*E)* that equals 1.0. However, targets measured in processes are *non-blackbodies*. Their emissivity values are less than 1.0, which means they emit a fraction of the infrared energy a *blackbody* would emit at a given temperature.

All Modline 5 Sensors are factory calibrated using *blackbody* standards. For accurate measurements, you must compensate for the difference between the emissivity of your target and that of a *blackbody* radiator.

Modline 5 Series Sensors, except the Series 5R, are single color brightness thermometers. Brightness thermometers depend upon the intensity of the infrared radiation. Since most process targets have an emissivity of less than 1.0, setting the Emissivity value to match the emissivity of the target material is necessary.

Series 5R Sensor use the two color ratio measurement described in Section 8.5 Ratio Sensors, page 148.

Methods of determining emissivity are described below.

8.4.1 Using Emissivity Tables

One way to determine an approximate Emissivity setting is to refer to a set of emissivity tables.

Table 17, Table 18, Table 19 and Table 20 are provided for this purpose. Emissivity values in the tables are based on actual tests on samples of the materials. Because the emissivity of most materials changes with wavelength, a separate column of emissivity values is provided for each Sensor series. To use the tables, locate your target material and obtain a value from the column for the Sensor series you are using. Adjust the Emissivity value setting to this value.

Most table values are in the form of ranges. This is because the details of an object's form and characteristics affect its reflectance (R) and transmittance (T). These factors in turn reduce the emissivity (E) value, as shown in the following general equation relating the three characteristics:

$E_\lambda = 1 - R_\lambda - T_\lambda$

Figure 90 shows how a target's surface characteristics affect its reflective properties, hence its emissivity. It is assumed in the figure that each sample of Material A is thick enough to be completely opaque (T = 0). Notice that a cavity in an opaque object comes very close to having blackbody characteristics; E = 1 when both R = 0 and T = 0.

From Figure 90, you can see why the lower value of a given range represents a flat, highly polished sample of the material. The upper value represents a sample of the material that has a flat surface that is as rough as might be expected when in its "crude" or "unfinished" form.

Some entries in Table 19 and Table 20 are marked with asterisks (*) to signify that the range of values results from more than just the target's reflective characteristics. These materials, in their specified forms, are partially transparent to infrared radiation. In spectral regions where the materials transmit energy, the emissivity typically increases with target thickness.

Follow the guidelines in the tables to estimate the emissivity of your target. Even a rough estimation can significantly improve the accuracy of your measurements over only using "averaged" values. Note that table entries having a single value represent targets in forms that are clearly specified.

You may wish to read the IRCON publication “Spectrum Reprint SR100 - Product Temperature Solutions — Temperature Errors Caused by Changes in Emissivity.

8.4.2 Using Emissivity Thermocouple Test

If your material is not listed in the table, or if you want to verify the emissivity value being used, you can test the emissivity of a target sample in the following lab setup.

1. Embed a thermocouple (30 or 36 gauge wire recommended) just under the surface to be viewed and heat the target to the desired temperature range. Allow the temperature indication from the thermocouple to stabilize.
2. Aim the thermometer sensor at the surface of the target sample (close to where the thermocouple is installed). Observe the temperature indication and adjust the Emissivity value setting so that this temperature indication matches the thermocouple reading. The value of the setting is the target emissivity.

8.4.3 Setting the Emissivity

The Emissivity may be set at the Sensor Rear Panel using the HEAD Menu **EMIS function** or with the **RS-485 EM Command**. An indirect method of setting the Emissivity is to use the **MATCH function or RS-485 MT Command. MATCH** allows inputting a temperature value known to be the true target temperature. The Sensor then automatically adjusts the Emissivity so that the temperature display indicates the same temperature. Instructions for setup are found in Section 5 Operation, page 90 of this manual.

A third way to adjust the Emissivity is to send a **scaled input** of 4 to 20 mAdc via the Orange and Orange/White twisted wire pair of the Sensor’s interconnecting cable. The Modline 5 senses an input and overrides any other setting of Emissivity or Match. Wiring and scaling information is in Section 4 Sensor Wiring, page 62 of this manual.

8.4.4 Using Relative Readings

True temperature readings are not always necessary. Relative temperature readings may suffice in applications where temperature variations, rather than precise temperature values, are of interest. It is not necessary to know the target's emissivity for relative temperatures. Meaningful relative temperatures can be obtained if (a) the Emissivity value setting is kept constant and (b) the target objects to be viewed are of similar form and composition. For relative readings, we suggest an Emissivity setting of 1.000.

8.4.5 Practical Limits on Emissivity

While all MODLINE 5 instruments are capable of emissivity settings of 0.100 to 1.000 it is not always advisable to use the lower emissivity settings. Potential temperature measurement errors due to background reflections are aggravated by a combination of decreasing target emissivity and decreasing target temperature. Temperature indications may become "noisy" due to the higher amplification at low emissivty settings.

For Series 56 and 5G Sensors it is recommended that the Emissivity setting be limited to 0.3 to 1.0 for the first 55°C (100°F) for all temperature ranges.

The more times reflected radiation "bounces" on a surface, the less reflective the target. This is because the surface absorbs more of the radiation at each "bounce", leaving less and less radiation to be reflected away from the surface.

Since targets that are less reflective have higher Emissivity, the rough surface and the cavity, illustrated in Figure 90, represent increasingly higher emissivity values—even though they are made from the same material as the polished surface.

It is best to measure targets with high emissivity values. High reflectance off or transmittance through the target introduces the possibility of measurement error due to background interference. Avoid reflections when measuring targets with Emissivity less than about 0.8.

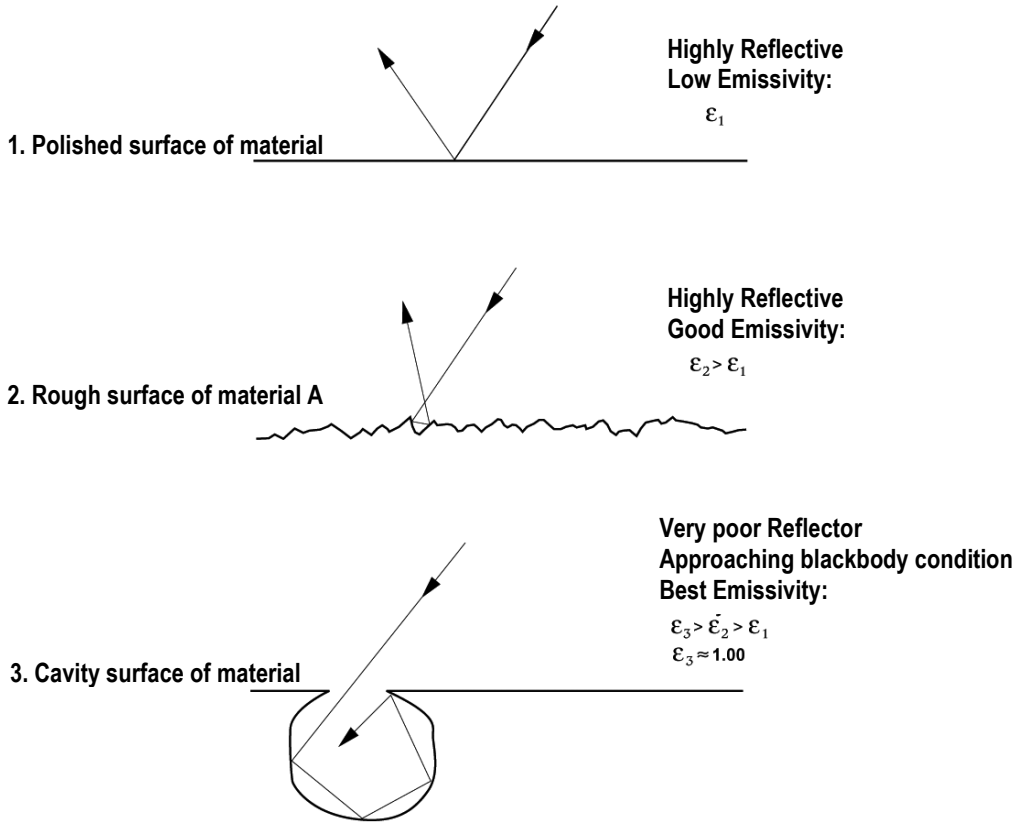


Figure 90: Surface Finish affects Emissivity

Emissivity Values of Metals and Alloys (Flat, Unoxidized Surfaces)

- Emissivity ranges shown represent differences in surface finish: mirror quality finish to dull, mill finish.
- Values for low-emissivity entries can be significantly greater than shown if surfaces are even slightly contaminated.

Material	Emissivity Range by Sensor Series		
	52, 5R (One Color Mode)	5G	56
Alumel	0.40-0.60	0.35-0.50	0.20-0.35
Aluminium	0.05-0.20	0.04-0.16	0.03-0.15
Brass	0.15-0.30	0.10-0.25	0.08-0.20
Bronze	0.20-0.40	0.15-0.30	0.10-0.25
Chromel	0.40-0.60	0.35-0.50	0.20-0.35
Chromium	0.40-0.60	0.35-0.50	0.30-0.45
Cobalt	0.25-0.40	0.20-0.35	0.15-0.25
Constantan	0.25-0.40	0.20-0.35	0.15-0.25
Copper	0.05-0.20	0.04-0.16	0.03-0.15
Gold	0.05-0.20	0.04-0.16	0.03-0.15
Inconel	0.40-0.60	0.35-0.50	0.20-0.35
Iron	0.35-0.50	0.25-0.40	0.20-0.35
Iron, Cast	0.35-0.50	0.25-0.40	0.20-0.35
Lead	0.25-0.40	0.15-0.25	0.10-0.20
Molybdenum	0.35-0.50	0.25-0.40	0.20-0.35
Monel	0.40-0.60	0.35-0.50	0.20-0.35
Nichrome	0.40-0.60	0.35-0.50	0.20-0.35
Nickel	0.30-0.50	0.25-0.40	0.15-0.30
Platinum	0.25-0.35	0.20-0.30	0.15-0.25
Silver	0.05-0.20	0.04-0.16	0.03-0.15
Steel, Carbon	0.35-0.50	0.35-0.40	0.20-0.35
Steel, Stainless	0.40-0.60	0.35-0.50	0.20-0.35
Tantalum	0.20-0.60	0.15-0.30	0.10-0.30
Titanium	0.40-0.60	0.30-0.50	0.20-0.35
Tungsten	0.35-0.50	0.25-0.40	0.10-0.25
Vanadium	0.35-0.50	0.30-0.40	0.25-0.35
Zinc, molten	0.20-0.40	0.15-0.30	0.10-0.25
Code 1			

Table 17: Emissivity Values of Metals and Alloys

Emissivity Values of oxidized Metals and Alloys (Flat Surfaces)

- Emissivity ranges shown represent differences in surface finish: smooth finish to rough, grainy finish
- Oxide film assumed to be sufficiently thick to avoid thin film interference effects

Material	Emissivity Range by Sensor Series		
	52, 5R (One Color Mode)	5G	56
Alumel, oxidized	0.60-0.85	0.60-0.85	0.60-0.85
Aluminium, anodized	–	–	–
Brass, oxidized	0.50-0.80	0.50-0.80	0.50-0.80
Bronze, oxidized	0.50-0.80	0.50-0.80	0.50-0.80
Chromel, oxidized	0.60-0.85	0.60-0.85	0.60-0.85
Chromium, oxidized	0.40-0.80	0.40-0.80	0.40-0.80
Cobalt, oxidized	0.40-0.80	0.40-0.85	0.40-0.80
Constantan, oxidized	0.60-0.85	0.60-0.85	0.60-0.85
Copper, oxidized	0.40-0.80	0.40-0.80	0.40-0.80
Inconel, oxidized	0.80-0.90	0.80-0.90	0.80-0.90
Iron, oxidized	0.80-0.95	0.80-0.95	0.80-0.95
Iron, Cast, oxidized	0.80-0.95	0.80-0.95	0.80-0.95
Molybdenum, oxidized	0.50-0.80	0.50-0.80	0.50-0.80
Monel, oxidized	0.60-0.85	0.60-0.85	0.60-0.85
Nichrome, oxidized	0.60-0.85	0.60-0.85	0.60-0.85
Nickel, oxidized	0.80-0.95	0.80-0.95	0.80-0.95
Steel, Carbon, oxidized	0.80-0.95	0.80-0.95	0.80-0.95
Steel, Stainless, oxidized	0.80-0.95	0.80-0.95	0.80-0.95
Tantalum, oxidized	0.40-0.80	0.40-0.80	0.40-0.80
Titanium, oxidized	0.50-0.80	0.50-0.80	0.50-0.80
Code 2			

Table 18: Emissivity Values of oxidized Metals and Alloys

Emissivity Values of miscellaneous Materials (Bulk, Normal Form)

- Unless otherwise noted, these materials have no transmittance in their normal form.
- Emissivity ranges shown for opaque materials represent differences in surface finish: smooth, polished finish to rough, uneven finish.
- Emissivities of partially transparent materials (*) will also increase with sample thickness.

Material	Emissivity Range by Sensor Series		
	52, 5R (One Color Mode)	5G	56
Asphalt, Tar, Pitch	–	–	0.95-1.00
Carbon, Graphite	0.75-0.90	0.70-0.85	0.65-0.80
Cinders, Slag, Cinkers	0.85-0.95	0.85-0.95	0.85-0.95
Coke	0.95-1.00	0.95-1.00	0.95-1.00
Firebrick[1], ~2" thick[1]			
high purity alumina*	< 0.20	< 0.20	< 0.20
high purity aluminum* silicate (Mullite)*	< 0.20	< 0.20	0.20-0.50
Foods, bulk (fruits, vegetables, oils, meats, bakery goods, etc.)	–	–	–
Gallium Arsenide solid polished, 0.5 mm-thick water	–	–	–
Glass, commercial soda-lime[1]			
0.05" thick*	< 0.05	< 0.05	0.05-0.10
> 4" thick	0.95-1.00	0.95-1.00	0.95-1.00
Oil, animal or vegetable 0.040"	–	–	–
Oil, mineral 0.040"	–	–	–
Paints, oil or water base[2]			
on metal*	–	–	–
on plastic or wood*	–	–	–
Code 3			

[1] Highly variable. Values for low emissivity entries can be significantly greater than shown if even small amounts of impurities are present.

[2] Paints with metallic pigments may have much lower emissivities.

Table 19: Emissivity Values of miscellaneous Materials

Material	Emissivity Range by Sensor Series		
	52, 5R (One Color Mode)	5G	56
Plastics			
all 1/8" thick	–	–	0.90-1.00
polyester film (mylar), 0.0002" thick*	–	–	~ 0.10
polyethylene film, 0.0002" thick*	–	–	~ 0.10
Rubber	–	–	0.95-1.00
Salt Baths	0.95-1.00	0.95-1.00	0.95-1.00
Silicon, solid polished 0.5 mm-thick wafer	–	–	–
Silicon, molten	~ 0.30	~ 0.30	–
Silicon, Carbide	0.80-0.85	0.80-0.85	0.80-0.85
Textiles, Fabrics			
Carpet (cotton, wool, synthetic)	–	–	–
Fabrics, close weave (cotton, wool, synthetic)*[3]	–	–	–
Leather	–	–	–
Water, 0.0002" film ☐	–	–	–
Wood	–	–	–
Code 4			

[3] Emissivity values may be significantly lower than shown for very sheer materials.

[4] Note that objects with even a very thin coating of water have very high emissivities.

Table 20: Emissivity Values of miscellaneous Materials (Continued)

8.5 Ratio Sensors

Modline 5 Series 5R Sensors utilize a dual detector assembly that measures temperature by comparing infrared radiation levels in two wavelength bands (0.85 to 1.05 microns and a narrow band centered at 1.0 to 1.10 microns). They have the capability to measure temperature by comparing the relative infrared radiance at two different wavelengths and computing the ratio of the two. Temperature readings are based on the ratio of the two signals in these bands.

See Section 3 Sensor Installation, page 22 of this manual for more information about signal reduction, resolving targets and other factors about using ratio sensors.

8.5.1 E-Slope Settings

When using a Series 5R Sensor as a two color ratio Sensor you must properly select the E-slope value. An E-Slope adjustment is provided to allow you to calibrate the Sensor to measure the temperature of the target material accurately.

Series 5R Sensors are commonly used for applications involving materials in one of two main classifications:

1. Greybody materials have an Emissivity that is the same at both detected wavelengths.
2. Materials with emissivities that are not the same at both detected wavelengths (a slope or variance in the emissivity at the two wavelengths exists).

The first of these, the class of greybody materials, contains those materials that have emissivities that are the same at both detected wavelengths. The most common greybody materials are described below. When your target is made from any of these materials and are oxidized, set the E-Slope Control of the Sensor to a value of 1.00.

Materials which require an E-Slope setting of 1.0:

- Blackbody calibration standard.
- Cavities in any opaque, isothermal body.
- The following metals when worked in air are subject to oxidizing: Iron, Cobalt, Steel, Nickel, Stainless Steel.

The second main classification is a family of metals with emissivity that exhibit a non-linearity (or slope) of approximately 1.06.

Materials which require an E-Slope setting of 1.6:

- Clean, smooth, unoxidized surfaces of the following metals: Iron, Molybdenum, Molten Grey Iron, Platinum, Cobalt, Rhodium, Nickel, Steel, Tungsten, Stainless Steel, Tantalum

If the materials in your process do not fall into either of these categories, you will have to test your product to find the appropriate E-Slope setting. To do this, sight the instrument on a sample target having a temperature that you have accurately determined by some other means (such as a reliable thermocouple). For best accuracy, select a temperature near the center of the instrument's range, or better still, carry out the test at several points throughout its range.

Adjust the E-Slope Setting until the indicated temperature matches the value you have previously determined. Set the E-Slope control to this value whenever measuring this type of target. If you use several tests, average the results and use the averaged value as your E-Slope setting.

8.5.2 Setting the E-Slope

The E-Slope may be set at the Sensor Rear Panel using the HEAD Menu **E–SL function** or remotely with the **RS-485 ES Command**. An indirect method of setting the Emissivity is to use the **MATCH function or RS-485 MT Command.** MATCH allows inputting a temperature value known to be the true target temperature. The Sensor then automatically adjusts the Emissivity so that the temperature display indicates the same temperature. Instructions for setup are found in Section 5 Operation, page 90 of this manual.

A third way to adjust the Emissivity is to send a **scaled input** of 4 to 20 mAdc via the Orange and Orange/White twisted wire pair of the Sensor's interconnecting cable. The Modline 5 senses an input and overrides any other setting of Emissivity or Match. Wiring and scaling information is in Section 4 Sensor Wiring, page 62. of this manual.

8.6 Peak Picker Signal Conditioning

Peak Picker signal conditioning is advisable for certain measurement situations.

- If the workpiece you are measuring is moving and is in the field of view for only a brief period of time.
- If a succession of small parts is to be viewed with variable spacing between them.
- If the temperature of a moving work-piece varies because of slag, oxides, etc. Using the Peak Picker allows measuring the highest temperature.
- If the line of sight between the instrument and the workpiece is momentarily or periodically interrupted, as by a moving piece of machinery or by bursts of steam or smoke.

Figure 91 illustrates the Peak Picker action. The Peak Picker circuitry responds to the highest instantaneous value of temperature and holds this value even if the temperature source is interrupted by one of the conditions listed above.

The indicated temperature (solid line) rises almost instantly, depending on the selected Response Time, to follow the peaks in actual temperature (dashed line). The indicated temperature decays at a rate determined by the setting of the Peak Picker Decay Rate. Figure 91 shows the effect of changing the decay rate.

The Peak Picker action affects the Temperature Display, Analog Current Output and RS-485 responses to commands.

8.6.1 Turning Peak Picker On and Off

The Peak Picker can be turned on and off by using the following:

1. The Sensor Rear Panel HEAD menu with the SIGL function. When the Peak Picker is selected, the PSEL function menu appears for setting of all the Peak Picker operating parameters. Operation of the SIGL, Peak Picker, PSEL, Decay Rate, Automatic Reset Below, Reset Below and Delay functions are explained in Section 5 Operation, page 90 of this manual.
2. Remotely using the RS-485 PK and related Commands. See Section 6 Digital Communications, page 114 of this manual.

When the Peak Picker function is turned on by using 1 or 2 above, a remote switch, as explained below, can enable or disable the Peak Picking signal conditioning.

8.6.2 External Switch for Remote Peak Picker Operation

The Modline 5 has a provision for a remote process controlled input switch to be wired to the Violet and Violet/White twisted wire pair of the Sensor's interconnecting cable. If Peak Picker signal conditioning is selected, the remote switch can enable or disable the Peaking action. With no switch or the switch in maintained in the open position Peaking action is enabled. With the switch closed, peaking action is disabled and the Sensor continuously indicates actual temperature variations as they occur. This can be called the Direct operating mode.

A momentary closure of the switch, greater than 0.08 seconds, resets the Peak Picker function to the current temperature reading. The peaking action begins again when the switch returns to the open position. Wiring and switch operation for the Peak PIcker are described in Section 4 Sensor Wiring, page 62 of this manual.

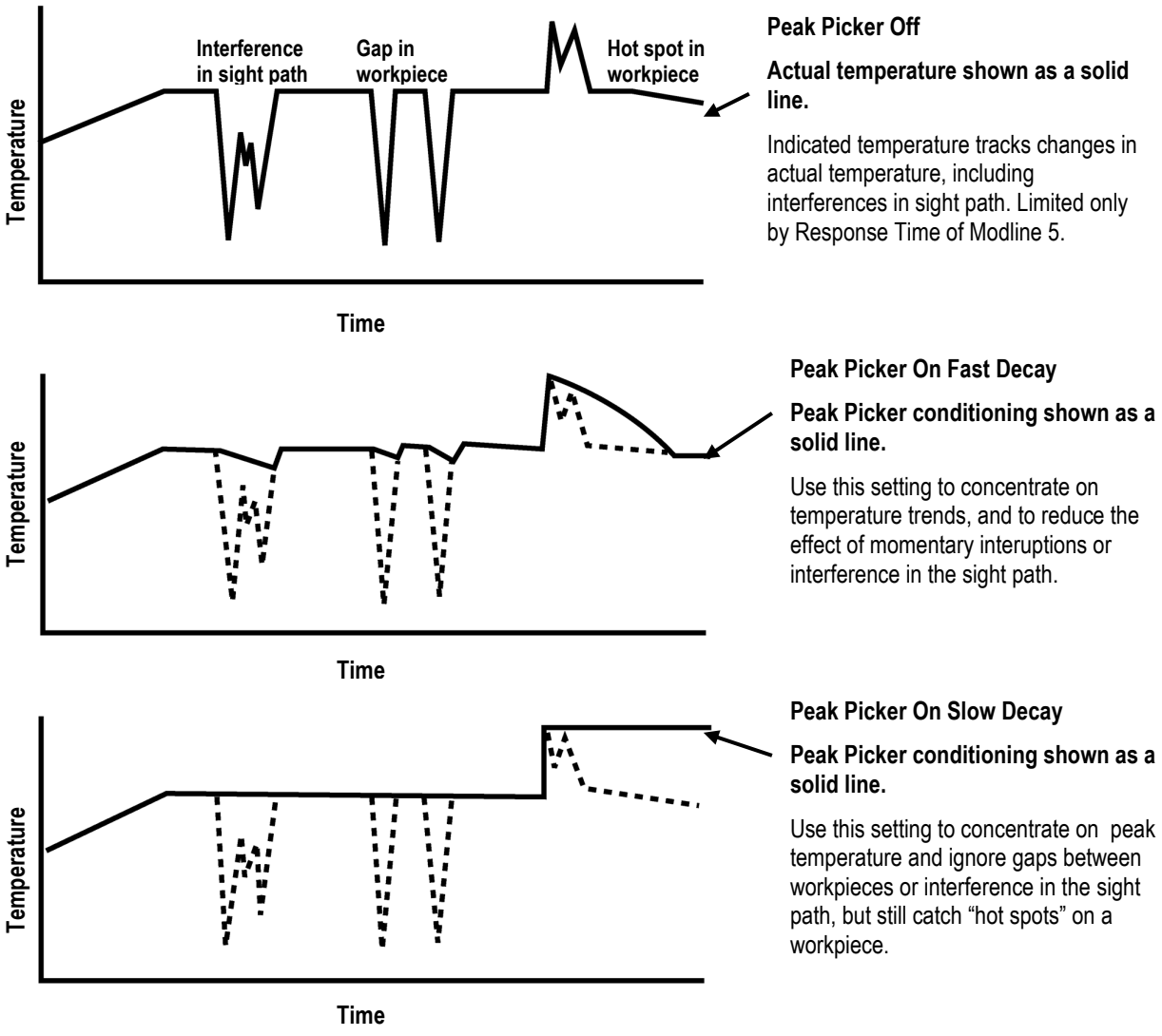

Interference in sight path
Gap in workpiece
Hot spot in workpiece
Temperature
Time
Peak Picker Off
Actual temperature shown as a solid line.
Indicated temperature tracks changes in actual temperature, including interferences in sight path. Limited only by Response Time of Modline 5.
Temperature
Time
Peak Picker On Fast Decay
Peak Picker conditioning shown as a solid line.
Use this setting to concentrate on temperature trends, and to reduce the effect of momentary interuptions or interference in the sight path.
Temperature
Time
Peak Picker On Slow Decay
Peak Picker conditioning shown as a solid line.
Use this setting to concentrate on peak temperature and ignore gaps between workpieces or interference in the sight path, but still catch "hot spots" on a workpiece.

Figure 91: Peak Picker Operation

8.6.3 Peak Picker Signal Conditioning

Peak Picker signal conditioning takes place with the Peak Picker on. Temperature readings may be returned to instantaneous values at any time by setting the SIGL function to OFF. The system then follows actual temperature variations as they occur.

Both Peak Picking signal conditioning and direct instantaneous temperature indication are affected by the selected Response Time.

8.6.4 Peak Picker Reset

The Peak Picker signal conditioning can be reset by any of the following actions:

- Manual reset using the Sensor rear panel PSEL menu RSET function.
- Remote reset with a momentary switch closure across the Sensor's interconnecting cable Violet and Violet/White twisted wire pair.
- Automatic reset using the Auto Peak Picker Reset function with Reset Below Temperature selection.
- Remote reset with the RS 485 PS Command

8.6.5 Peak Picker Decay Rate

The Decay Rate is set to retain peak measured temperature value and ignore momentary decreases in measured temperature caused by process conditions. The goal is to eliminate erratic measurements due to gaps in work pieces, bursts of smoke, or steam, etc. in the sight path of the Sensor.

The Decay Rate range is 0.00 to 300 degrees. The Decay Rate setting is unit-less. The units are defined by the selected Sensor measurement units, Fahrenheit or Celsius.

The fastest decay rate is 300 degrees per second. The slowest decay rate is 0 degrees per second. This slowest decay, for practical purposes, can be considered as a Peak Hold with the highest peak measured temperature held until a Reset occurs.

Select a Decay Rate that will yield the decay needed for meaningful process measurement. Refer to Figure 91.

8.6.6 Auto Peak Picker Reset with Reset Below

An automatic reset is accomplished with the Auto Peak Reset and Reset Below functions. These functions are turned on with the Sensor rear panel PSEL menu AUTO and RBEL functions or the RS-485 **PS** and **PK Commands**. Figure 92 illustrates Auto Peak Picker Reset.

This reset action is triggered when the measured temperature goes below the selected Reset Below Temperature.

When the measured temperature is below this temperature, the displayed temperature indication will be the measured temperature unaffected by the Peak Picker signal conditioning, subject to any Response Time selection.

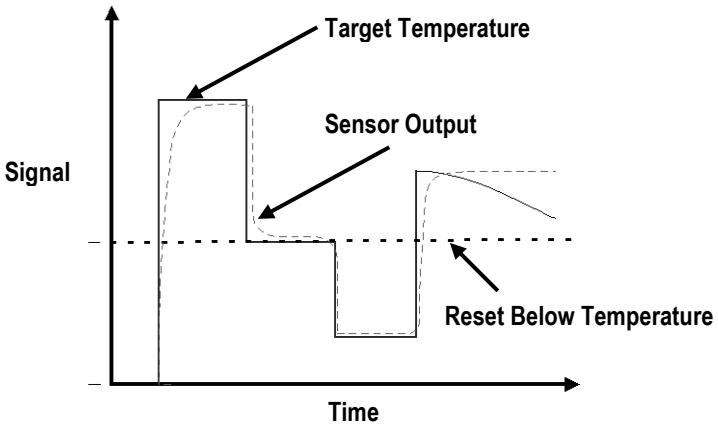


Figure 92: Automatic Peak Picker Reset

When the measured temperature is above the selected Reset Below Temperature the displayed temperature will be the measured temperature with the Peak Picker signal conditioning action applied subject to the selected Response Time. The Auto Peak Picker Reset can effectively be used to turn ON the Peak Picker function when the target is in view and to turn it OFF when the target is out of view.

The Reset Below temperature must be properly selected to provide the measurement conditions wanted. Too high of a selected temperature may cause the peaking action not to be activated if the target is cooler than the selected temperature. If the Reset Below temperature selected is too low Peak Picker action will continuously take place with higher background temperatures.

Auto Reset can be affected by long response times. The selected Response Time should be fast enough to allow the selected Reset Below Temperature captured and be used to accomplish the reset.

8.6.7 Peak Picker Delay

The Peak Picker Delay function is used to delay the start of the peaking action for up to 10 seconds following the detection of the leading edge of a new target. This function is turned on with the Sensor rear panel PSEL menu DEL function or the RS-485 PD Command. It operates independently of the Auto Reset and reset below functions.

It has limited operation when used with Peak Picker signal conditioning without the Auto Peak Picker Reset function. It will provide the selected delay for the first hot target seen after any Peak Picker Reset. The reset can be from the Sensor rear panel, a reset from a momentary closure of the Peak Picker Reset external switch or a reset from the RS485 PR command

The primary use of Peak Picker Delay is with the Auto Peak Picker Reset and Reset Below Temperature functions as explained below.

The Peak Picker Delay time-out will be not begin until a target whose temperature is above the selected Reset Below Temperature comes into view and remains in view. Figure 93 shows the delay time in relation to the target temperature and the reset below temperature level. The Peak Picker action will begin after the selected delay time and will continue until the actual measured temperature

goes below the selected Reset Below temperature. The system will then return to direct temperature indication until a new target comes into view. The Decay Cycle will repeat as describe above.

Delaying the start of the peaking action allows peaked temperature measurement of targets with hot leading edges and cooler middle temperatures without peaking on the hotter leading edge. The delay time selected determines at what position or point on the target peaking action begins. This function may be affected by a slow Response Time which could further delay the start of peaking action.

Example: Before a moving work piece enters the target viewing area, the System may be sensing a measured temperature below the selected Reset Below temperature. As the target comes into view, the hotter temperature is sensed and the Peak Picker Delay time-out begins. When the delay is completed, the system will begin peaking action on the measured temperature until the work piece passes the Sensor.

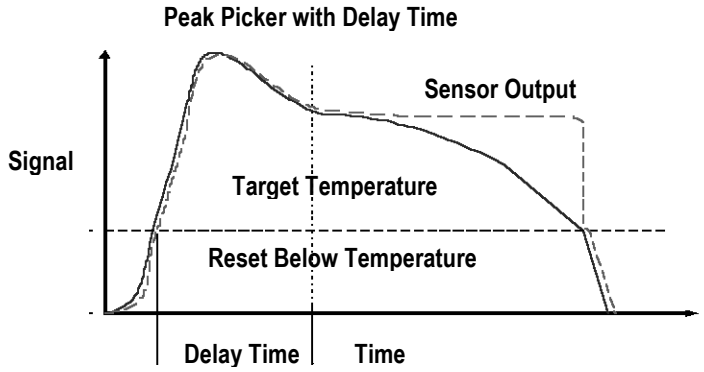


Figure 93: Peak Picker Delay

The Delay Time can be used with the Auto Reset turned off. In this case, the Delay will only begin after a reset occurs. See sub section Peak Picker Reset above for how to initiate a reset.

8.7 Track and Hold

The Modline 5 includes a Track and Hold function that allows continuous temperature measurement in the Track mode and suspended measurement in the Hold mode with the last temperature reading held. Selection of the Track and Hold function is made with the Sensor rear panel SIGL menu and TRAK function or the RS-485 TS Command.

8.7.1 External Switch Control of Track and Hold

The Modline 5 has provisions for a remote process controlled input switch be wired to the Violet and Violet/White twisted wire pair of the Sensor's interconnecting cable. If Track and Hold signal operation is selected, the switch input is required to change from Track temperature operation to Hold temperature mode as required in the process system. Figure 94 illustrates Track and Hold operation.

The Sensor will be in the Track Mode with the switch open and in the Hold mode with the switch closed.

- The remote switch may be manually operated or it may be a contact on a timer, relay, or movement of a target or its timing in the process to close the remote switch.

- Track and Hold temperature readings are affected by the Response Time setting.

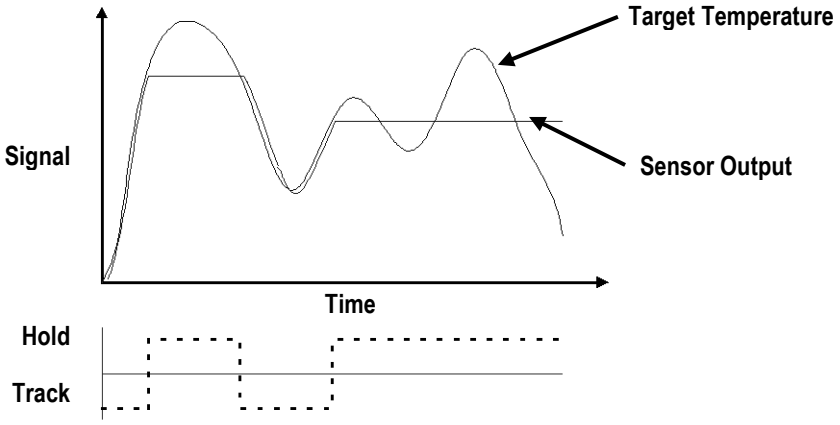


Figure 94: Track and Hold

Example: you may want to scan the surface of a moving workpiece and hold the temperature reading at middle point on the workpiece, while ignoring the readings at the beginning and the end of the workpiece.

Another Example: the temperature tracking can be made to hold a temperature even after the temperature in the sighted area has dropped. It will hold the value without any decay until the switch is opened.

Peak Picker and Track and Hold Signal conditioning cannot be simultaneously selected. Use of Peak Picker with zero or very low Decay rates and an external reset can accomplish similar results.

8.8 Avoiding Common Measurement Problems

8.8.1 Viewing Angle Limitations

Acute viewing angles can present the problem of reduced emissivity values, particularly if you are dealing with smooth target surfaces.

Figure 95 shows the permissible angles (for all Sensor Series) when viewing smooth surfaced objects such as metals, glass or plastics. Angles up to 45° from the perpendicular usually will not appreciably affect the measurement, although the smaller the angle from the perpendicular the better. In general, angles greater than 45° should be avoided. An increase in reflectance occurs when smooth surfaces are viewed at large angles, and consequently the target emissivity decreases.

8.8.2 Background Interference

Under ideal circumstances, the radiant energy being measured should be from the target only. This is why you must center the Cone of Vision on the target and make sure that its cross-section (spot size) is smaller than the target. That way the sensor can't "see" past the target into the background. Although the Sensor Models 5R have somewhat looser restrictions on filling the field of view, it is still affected by background interference if significant sources of background radiation are present.

Significant background radiation comes from comparable temperature or hotter objects in the target's surroundings. This background radiation may be reflected off, or transmitted through, the target adding to the radiant energy detected by the instrument related to the target temperature. This results in measured temperature error. For all Modline 5 Sensor Series, except the Series 5R, this extra radiation, if detected, causes a temperature indication that is higher than the target's true temperature.

For Series 5R Sensors, background interference that is slightly cooler than the target results in temperature indications that are too low. When the background temperature is much lower than that of the target, however, the indicated temperature is unaffected. If the interfering background sources are hotter than the target, the indicated temperature is too high. There is no error in the indicated temperature, with a Series 5R Sensor, when the background temperature matches the target temperature.

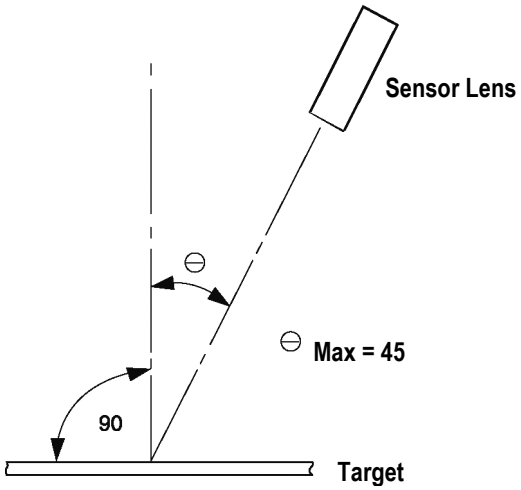


Figure 95: Viewing Angle

When the environment includes unfiltered background light or heat sources, select a viewing arrangement that minimizes these problems. In general, the higher the target's Emissivity, the less susceptible the measurement is to errors.

Emissivity (E), Reflectance (R), and Transmission (T) are related as follows:

$E_\lambda = 1 - T_\lambda - R_\lambda$

Maximum accuracy is possible when E = 1.0 (blackbody condition). In this condition, there is no reflection and no transmission of background energy to cause measurement errors.

As emissivity decreases it is harder to get accurate readings because reflectance and/or transmittance become more pronounced. Use caution when attempting to measure materials with emissivity values known to be 0.2 or less.

8.8.3 Transmission Effects

If the target has some transmission at the operating wavelength, it can act as a window for infrared emission from objects behind it (e.g. an oven wall or heating element). Such problems can sometimes be corrected by changing the viewing angle so that the background source is not directly behind the target, by selecting a different measurement point away from the background source, or by inserting a

cooled shield behind the workpiece. See Figure 96 for examples. These considerations apply to all Sensor series.

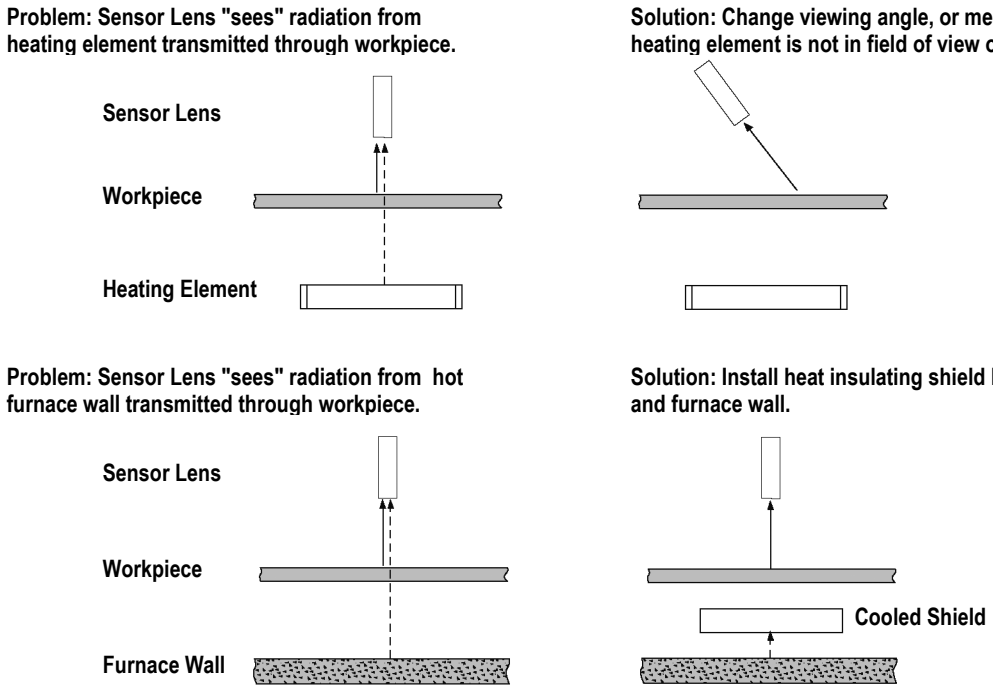

Problem: Sensor Lens "sees" radiation from heating element transmitted through workpiece.
Sensor Lens
Workpiece
Heating Element
Solution: Change viewing angle, or measuring location, so heating element is not in field of view of sensor.
Problem: Sensor Lens "sees" radiation from hot furnace wall transmitted through workpiece.
Sensor Lens
Workpiece
Furnace Wall
Solution: Install heat insulating shield between workpiece and furnace wall.
Cooled Shield

Figure 96: Solving Common Transmission Problems

8.8.4 Transmission Path Effects

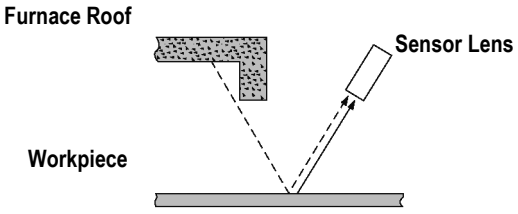
Materials in the transmission path may absorb infrared radiation, reducing the amount of radiant energy an instrument receives. This is less of a problem for Series 5R Ratio Sensors, as long as the radiance at both detected wavelengths is reduced equally. For any other Sensor Series, a poor transmission path causes the indicated temperature to be lower than the target's true temperature. These problems may be minimized by keeping the System's optical components clean, and by selecting a sight path for which the entire optical cone between the target and the instrument is free of solid objects, dust, smoke, and evaporates. Sight tubes, shown in Figure 97 can be used for this purpose. For information on the use of windows, refer to Section 8.10 Use of Windows, page 158.

8.8.5 Reflectance Effects

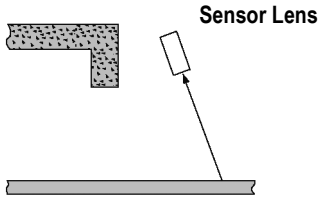
If the target has some reflectance, it acts as a mirror and reflects infrared energy generated by other sources (e.g. a furnace wall or heating element). If the Sensor picks up the reflection, measurement errors will result. Reflectance depends on the target material and the condition of its surface. Flat, smooth surfaces tend to have larger reflectance values than roughened surfaces of the same material. Reflectance problems may be reduced by changing the viewing angle so that the reflection is not picked up by the Sensor, or by the use of sight tubes or some other form of shielding. (See Figure 97 examples.) These considerations apply to all Sensor Series.

Viewing at furnace exit

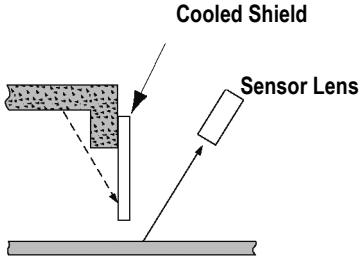
Problem: Sensor Lens "sees" reflections of furnace roof or wall.



Solution 1: Change viewing angle.

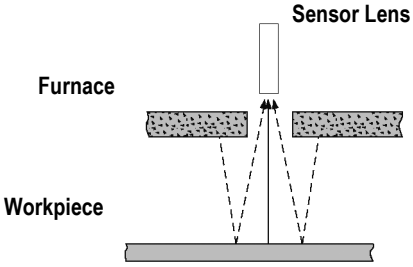


Solution 2: Install shield to block reflection.

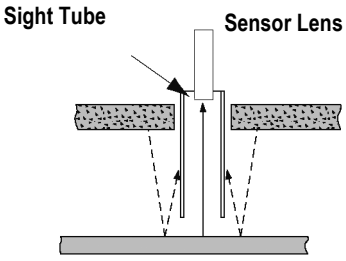


Viewing through furnace roof or wall

Problem: Sensor Lens "sees" reflections from hot of furnace roof.



Solution: View through sight tube with tip spaced close to surface of workpiece.



Cautions: 1. I.D. of sight tube must be wider than Cone of Vision along entire length. (See Section 3)
2. Sight tube walls may radiate infrared if furnace atmosphere is very hot. May require cooled sight tube. Consult IRCON for recommendations.

Figure 97: Solving Common Reflection Problems

8.9 Use of Mirrors

In rare situations it may be difficult, if not impossible, to position the Sensor for a direct view of the desired target surface. You may then find it necessary to view the target indirectly by means of a mirror. Mirror material, surface area and alignment are critical in this application. In all cases the mirror must be a first surfaced (front surfaced) mirror, and ideally it should be a perfect reflector at the operating wavelength of the Sensor.

A first surfaced, flat, aluminized or gold mirror may be used for all Sensor Series except Series 5R. This type of mirror is readily available from optical supply houses. For 5R Sensors, the mirror must be a front surfaced, gold coated mirror. (Aluminum coated mirrors show a small coloring effect in the Series 5R spectrum, causing the instrument to read low. This low reading error may be corrected by the E-Slope adjustment, but a gold mirror is preferred.).

As indicated in Figure 98, the Cone of Vision extends from Sensor-to-mirror-to-target. The mirror effectively bends the cone but does not change its shape.

There are two spot sizes to consider in Figure 98: spot size d1 at the mirror surface (distance D1) and spot size d2 at the target surface (distance D2). Mirror and target areas must be at least twice the cone diameter at their respective distances.

The mirror must be positioned (and angled) so that the axis of the reflected target image coincides with the optical axis of the Sensor. You should be able to accomplish the alignment without difficulty by sighting through the viewing telescope.

Be sure to lock the mirror firmly in position, and check the alignment on a regular basis. Also, inspect and clean the mirror (in manner recommended by the manufacturer) as part of your regular maintenance routine. If you have any trouble in obtaining an appropriate mirror or in erecting your system, please contact IRCON for recommendations.

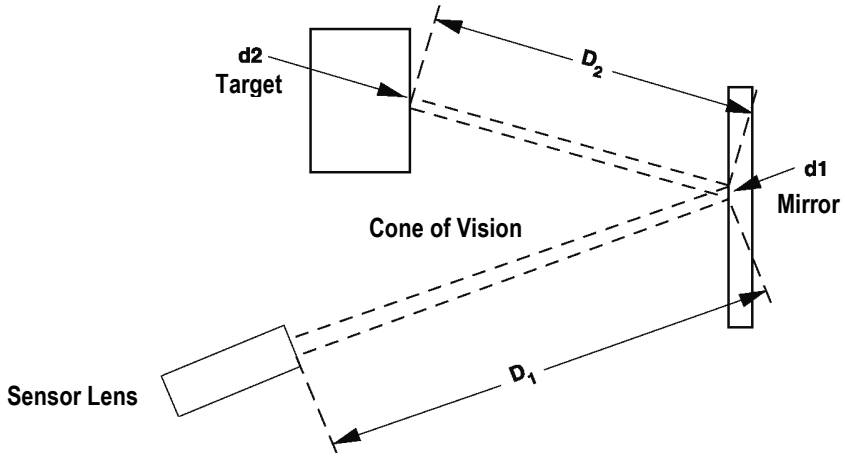


Figure 98: Effect of Using a Mirror on Optical Cone

8.10 Use of Windows

To view an object in an inert atmosphere or vacuum chamber, you must use an infrared transmitting window. Selection of an appropriate window material will depend on the Sensor's spectral response. Some suggested window materials for various Modline 5 Sensor Series are listed in the Window Selection Guide Table 21.

Available Windows (Specifications: Optical Grade, 1/8 inch thick, Polished to "Plate Glass" Finish)					
Series	**Pyrex #7740**	**Fused Quartz (G.E. #124 or eqiv.)**	**Synthetic Sapphire**	**Calcium Fluoride**	**Cleartran (ZnS)**
52, 5G	Suitable T=0.92	Recommended T=0.94	Suitable T=0.85	Suitable T=0.94	Suitable T=0.94
5R	No	Recommended T=0.94	Suitable T=0.85	Suitable T=0.94	Suitable T=0.94
56	No	Recommended T=0.94	Suitable T=0.85	Suitable T=0.94	Suitable T=0.94

Table 21: Window Suitability and Transmission Factor T

The window material must be highly transparent in the Sensor's infrared spectral region. Yet, there is always some signal loss due to reflection or absorption when using a window. To compensate for this

loss, first multiply the emissivity of the target object by the window's transmission factor (T) shown in the Window Selection Guide. Then adjust the emissivity setting to this value.

Example:

Emissivity of object = 0.8
Transmission factor of window = 0.92
Emissivity setting = 0.8 X 0.92 = 0.74

The window specifications given at the top of the chart are suitable for most applications. However, high pressure or vacuum chamber applications may require windows that are thicker than 1/8" (3 mm). Be aware that transmission of thicker windows may be significantly degraded.

It is good practice to use a window at least twice the diameter of the Cone of Vision at the point where the window is to be installed. Note that the dimensions of the Cone of Vision can be changed by focusing the optics. It is essential for all Sensor Series except Series 5R that you never allow any part of the Cone of Vision to be obstructed. Figure 99 illustrates the correct use of windows. Keep the window clean to prevent low temperature indications.

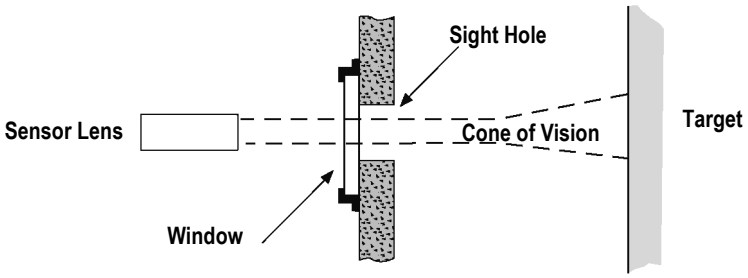


Figure 99: Viewing a Target through a Sight Hole and Window

8.10.1 Special Considerations for Ratio Units

Because Modline Series 5R ratio Sensors compare the radiation detected at two separate wavelengths, the best windows for these units have the same transmission value at both wavelengths. All acceptable Series 5R windows specified in the Guide have this characteristic. No additional E Slope adjustment is required when these windows are used.

Note that certain materials, which are transparent to the human eye, can cause serious measurement errors when with a 5R Ratio Sensor. For instance, it almost always causes problems if any of soda-lime plate glass, "PLEXIGLASTM", water, or "PYREXTM" glass lies between the Sensor and the target during a measurement. Similarly, if you need to reflect your target's radiation in order to measure it with a 5R Ratio Sensor, use a front surface gold mirror, not a mirror with an aluminum reflecting surface.

The materials listed in the Guide are not all common optical materials and you may have some difficulty locating a source for windows. If you do, here are some suggestions.

Adolph Meller Optics
P.O. Box 6001
Providence, Rhode Island
02940, 401-331-3717

Karl Lambrecht Corp.
4204 Lincoln Ave.
Chicago, Illinois 60618
773 -472-5442
www.klccgo.com

Janos Technology Inc.
Route 35, Townshend
Vermont 05353, 802-365-7714
www.janostech.com

8.11 Preventing Sensor Overheating

The Modline 5 Sensor can be cooled with the WJA accessory presented in Section 3 Sensor Installation, page 22. Do not use a WA-3 accessory for cooling.

Under extreme conditions, it may be necessary to provide insulation and reflective shielding for additional protection from high ambient temperatures and radiated heat using materials available at the installation site.

Figure 100. shows one means of providing insulation protection. In this example, a Sensor is mounted at a sight hole cut into a furnace wall. The Sensor is protected from the atmosphere by a water cooling accessory and is insulated from the atmosphere near the wall by aluminum-backed insulation.

A radiant heat shield can be any reflective metal shield in the path between the heat source and the Sensor, as in Figure 101. It should be close enough to the Sensor to block random reflected radiation, but with a space between it and the unit to allow air to circulate between them.

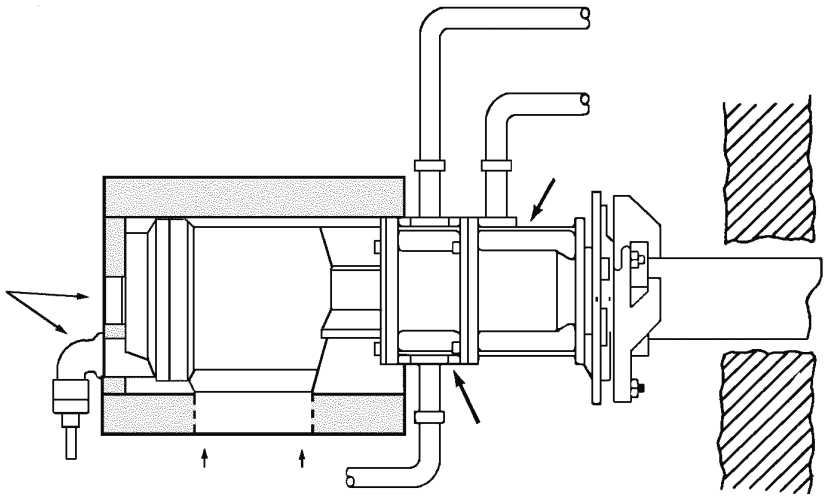


Figure 100: Sensor Water or Air Cooling with Added Insulation Wrap

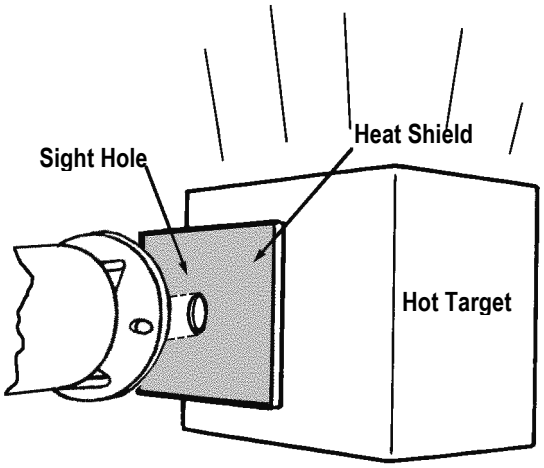


Figure 101: Protection Using Reflective Heat Shield

9 DPM Installation and Operation

9.1 Introduction

The IRCON Model DPM is an accessory to the Modline 5 Series of Infrared Thermometers. As a remote operator interface, the DPM provides complete setup of the Modline 5. It connects to the Sensor's RS-485 Digital Communications to interface with the Sensor. Read and Write commands are used to obtain and display temperature measurement values and Sensor status, including diagnostic Alarms.

The DPM can also be used as a read only device by configuring the Sensor to accept read commands only. The DPM can be programmed to display stored Maximum and Minimum temperatures as well as the current temperature. With the optional Quad Relay Card, four setpoints can be used as temperature alarms.

The DPM is an OEM product supplied by Red Lion Controls.

9.1.1 Using the DPM

The following steps are necessary to use the DPM.

- Prepare and install the DPM as instructed in Section 9.2 DPM Installation, page 162.
- Be thoroughly familiar with the operation of Sensor as explained in Section 5 Operation, page 90 of this Modline 5 Manual.
- Follow the safety warnings, cautions and Instructions for safe Laser operation provided in this Modline 5 Manual.
- Install and wire the Modline 5 Sensor per the Instructions in Section 3 Sensor Installation, page 22 and Section 4 Sensor Wiring, page 62 of this Modline 5 Manual.
- Prepare the Sensor to communicate with the DPM per the instructions provided Section 9.3 Modline 5 Laser Sight Option, page 165.
- Program the DPM Quad Relay Setpoints and MAX and MIN features of the DPM if those features are being used. See the information provided under Full Programming in Section 9.14 Full Programming Mode, on page 175.
- Do a complete initial Sensor setup with the DPM.

9.2 DPM Installation

Figure 102: DPM Meter Front

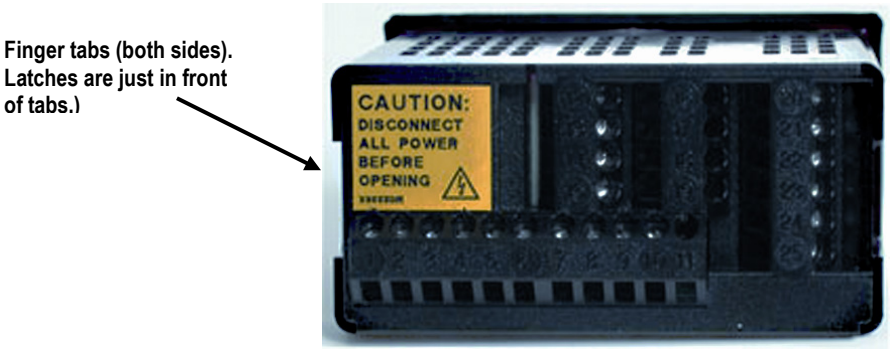


Figure 103: Rear Wiring Terminals

9.2.1 DPM Pre-installation

The DPM is delivered in a separate carton. Remove the DPM meter, its mounting clip and gasket, an F and C overlay with insert frame kit, and Red Lion Controls Bulletin No. PAX - B, or later release, from the carton. All items are needed, keep them all.

The Red Lion Bulletin No. PAX - B contains installation and wiring information for the DPM. Refer to Sections 2 and 4 for Panel Installation and AC wiring instructions. The bulletin also contains safety information and lists CE and safety compliances.

9.2.2 F and C Units Overlay (Part Number 478432/SBPAX03)

Before installing and wiring the DPM, determine the measurement units to be used and install an F or C overlay behind the DPM Front Window as instructed below. Refer to the photographs above and those that follow.

If an overlay is not used, the LED backlights will be visible. See Section 9.13 DPM Sensor Diagnostic Functions, page 174 to turn backlight off.

Exposed line voltage exists on the circuit boards. Remove all power from the meter AND load circuits before accessing the unit to apply overlays or install relay cards.

Circuit cards contain static sensitive components. Before handling cards, discharge static charges from your body by touching a grounded bare metal object. Ideally, handle cards at a static controlled clean workstation. Handle cards by the edges. Dirt, oil or other contaminants may contact the cards and adversely affect circuit operation.

Remove the meter base from the case by firmly squeezing and pulling back on the side rear finger tabs. This should lower the latch below the case slot (which is located is located just in front of the finger tab). It is recommended to release the latch on one side, and then start the latch on the other side.

Figure 104

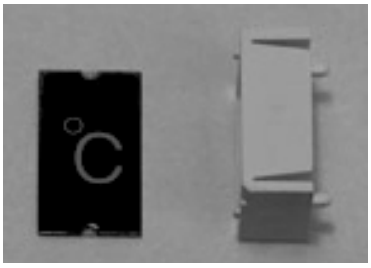


Figure 105

Choose an F or C overlay and remove the opaque release paper from its adhesive side. Attach the overlay to the front of the white overlay frame insert. Align the overlay with the two very small pins on the front of the frame. Remove clear protective film from overlay. Insert the long pins on the frame into the matching holes on DPM display board.

Before returning meter to its case, install optional Quad Relay Card if supplied. See instructions below.

Slide the assembly back into its case. Be sure the rear cover fully latches into the case.

9.2.3 Quad Relay Card (Part Number PAXCDS20)

If an optional Quad Relay Card has been purchased, the card is delivered as an accessory item in a separate carton. The relay card, a label for the meter case and Red Lion Bulletin PAXCDS-C, or later release, are in the carton.

Read and follow all warnings, installation and operation instructions in the Red Lion Bulletin. Adhere the wiring label supplied with card to DPM case in the space provided beneath main label. A simplified initial Setpoint setup is found in Section 9.13 DPM Sensor Diagnostic Functions, page 174.

The quad relays are intended for use as temperature alarms, not closed loop process control. Determine if use of the relays are adequate for the process requirements.

9.2.4 Panel Installation and Wiring

Install the DPM as per all installation instructions in Red Lion Controls Bulletin No. PAX- B supplied. A cutout template and instruction are supplied in bulletin Section 1.0.

9.2.5 Sensor RS485 Connections:

See Section 4 Sensor Wiring, page 62 for recommended computer cable type and shielding information.

DPM Terminal 12 to Modline 5 Sensor Cable Yellow wire
DPM Terminal 13 to Sensor Cable Yellow/White.
DPM Terminal 14 to Sensor Cable Red/White (power supply common direct wire connection to TSP Plate or POI Box. Do not use shortcut wiring route to any other point(s).

User 1 Input Jumper
The DPM is supplied with a jumper installed between the User 1 input terminals 7 and 8. Jumper can be replaced with a SPST switch if it is anticipated that full programming access is going to be required often. Ircon recommends that the simple jumper be used unless you intend to become thoroughly familiar with the DPM and use other features.

9.2.6 AC Power Wiring

Reference Red Lion Bulletin No. PAXP Section 3.0 for AC power wiring. Follow all warnings and instructions.

Quad Relay Connections
If optional Quad Relay Card is installed, wire relays per Red Lion Controls Bulletin PAXCDS-C supplied with the Quad Relay Card. Follow all warnings and instructions.

9.2.7 Critical Process Safety Guideline

When this instrument is being used in a critical process that could cause property damage and personal injury, the user should provide redundant device or system that will initiate a safe process shutdown in the event that this instrument should fail. The user should follow NEMA Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control. A copy of the standard is reprinted in Appendix A.

9.3 Modline 5 Laser Sight Option

The Modline 5 Laser Sighting Option can be turned on remotely using the Laser Function in the Engineering parameter section. Follow all cautions and instructions shown below and in Section 5.11 Laser Sighting Operation, page 110 of this Modline 5 manual.

Before turning on the Laser remotely with the DPM Digital Panel Meter Interface or other devices using RS– 485 Communications, insure there are no personnel in the path of the beam.

9.4 RS-485 Communication Setup

The following Sensor RS-485 Communication parameters must be correctly selected at the Sensor Rear Panel for communications to take place. RS-485 Commands for these functions are not provided. The parameters cannot be remotely selected by the DPM. Instructions are in Section 5 Operation, page 90 for the following functions.

If the Sensor is connected to the DPM, these parameters must be set while the DPM is in the DSP Display Mode.

9.4.1 CLCK – Communications Lock

Communications Lock provides for the configuration of the Modline 5 RS-485 Communications. Communication can be configured to allow selection and adjustment of functions with Read and Write (R / W) operation. Alternately, Read Only (R/O) operation does not allow Sensor to execute write commands.

The Sensor must be set to (R / W) operation to use the DPM as a programming interface.

The Sensor can be set to (R / O) operation to use the DPM as Read Only Device. R / O operation allows the CHK function to initiate a System Check and RSET to perform a Manual Peak Picker Reset as described in this Section 9.

9.4.2 ADDR – Sets the Sensor Address

The Unit Address is a one digit number or single letter code. It ranges from a single numeric 0 to 9 and upper case A to Z. The Address factory default setting is 0 (zero). It is recommended, but not necessary, that the address be set to 0. The DPM uses the (?) wildcard address that all Sensors recognize.

9.4.3 BRAT – Baud Rate

The Sensor Baud Rate must match that of the other RS-485 device. The DPM uses 9600 Baud. Four baud rates are supported by the Sensor (9600, 19200, 38400, and 57600 bits of information per second).

Set the Sensor Baud Rate to 9600.

9.5 DPM Operation – Introduction

Investigate all alarms indicated by the Flashing ALM indicator. Temperature readings on rear panel display, at Analog Output or from RS-485 Communications may be inaccurate with Error Code X101 through X109 Alarms. ALM indicator flashes only in Display Mode.

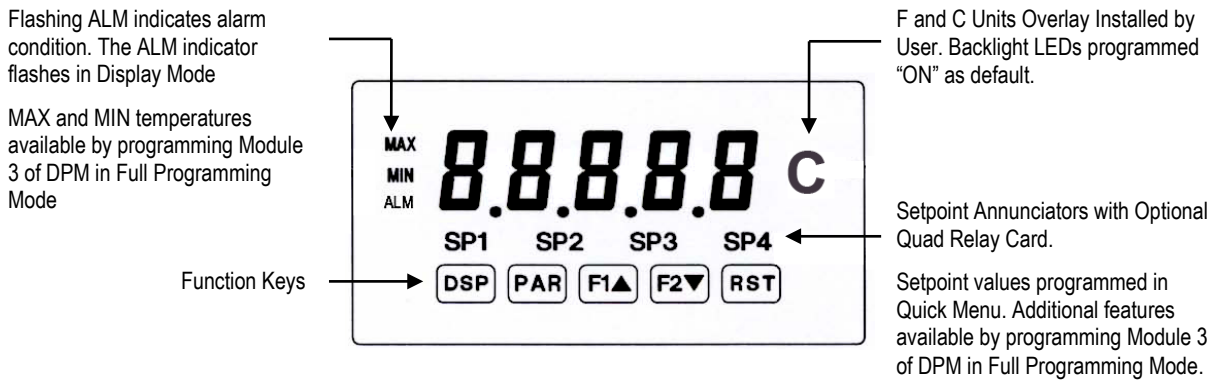
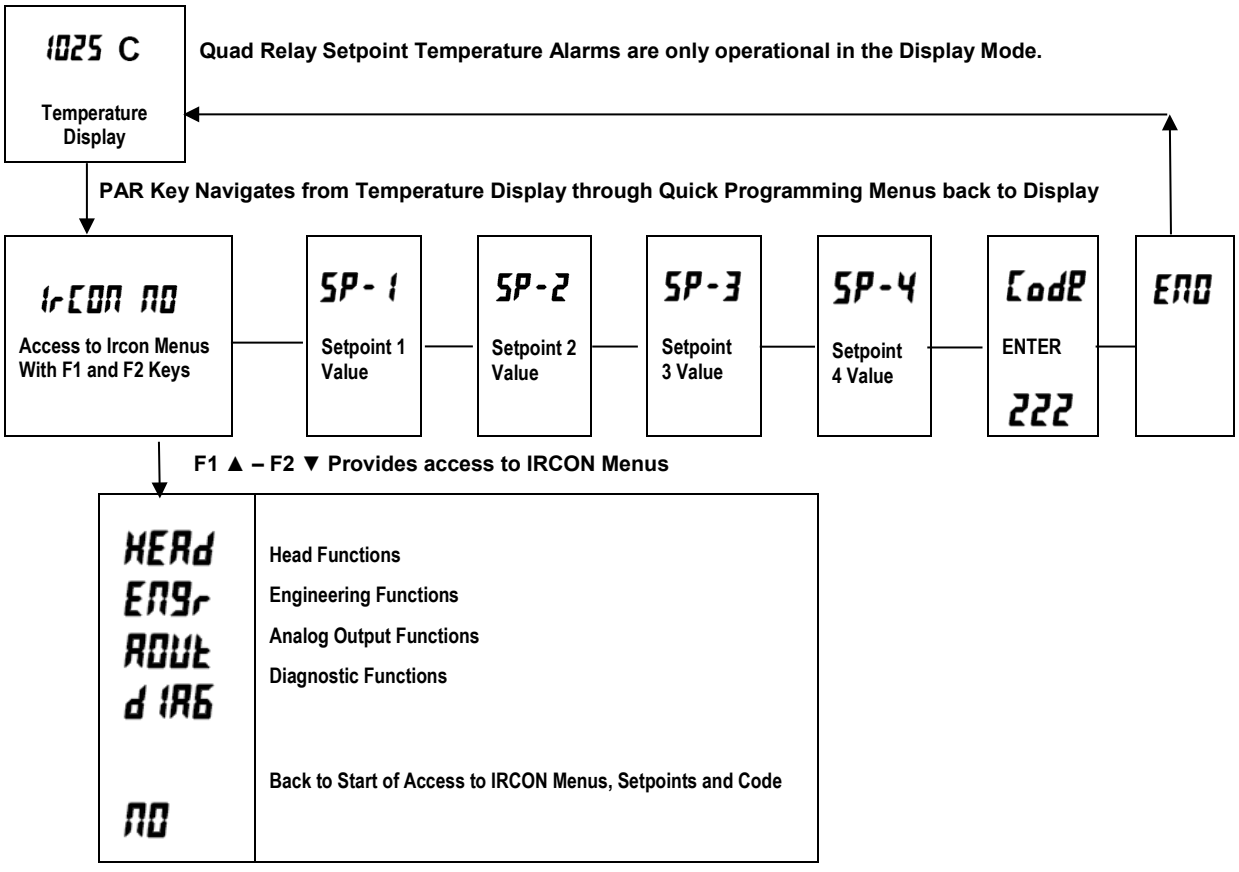

Flashing ALM indicates alarm condition. The ALM indicator flashes in Display Mode
MAX and MIN temperatures available by programming Module 3 of DPM in Full Programming Mode
F and C Units Overlay Installed by User. Backlight LEDs programmed "ON" as default.
MAX
MIN
ALM
8.8.8.8.8 C
SP1 SP2 SP3 SP4
Function Keys
DSP PAR F1▲ F2▼ RST
Setpoint Annunciators with Optional Quad Relay Card.
Setpoint values programmed in Quick Menu. Additional features available by programming Module 3 of DPM in Full Programming Mode.

Figure 106: Temperature Display and Function Keys.

9.6 Display and Programming Flow Diagram



9.7 Sensor Setup with the DPM

HEAD (Sensor Operating Functions List)

EMIS (Set Emissivity for Brightness or 1 Color Sensor)
E-SLP (Set E-Slope for 2 Color Ratio Sensor)
R.T. (Set Response Time)
SIGL (Signal Conditioning Peak Picker or Track/Hold)
PSEL (Peak Picker Sub Function Settings)
COLR (Set Ratio Unit for 2 Color or 1 Color Operation)
MTCH (Match Known Temperature)

SUB FUNCTION PSEL (Peak Picker Function Settings)

D.R. (Decay Rate in °F or °C per Second)
RSET (Manual Peak Picker Reset)
AUTO (Auto Peak Picker Reset)
RBEL (Reset Below Temperature)
DEL (Peak Signal Conditioning Delay)

ENGR (Engineering Functions List)

LOCK (Sensor Rear Panel Lockout)
MODL (Model Number Scroll)
F/C (°F and °C Selection)
RELY (Alarm Relay Operation Setup)
CHK (Initiate System Check)
HOUR (Automatic System Check Setup)
WRNL (Optional Dirty Window Detector Setup)
L**ASER** (Energize Laser)
VER (Sensor Firmware Version)
I ALM (Sets Ratio Invalid Measurement Condition as Alarm)

AOUT (Analog Signal Output Current Range Selection and Temperature Scaling)

SOUT (Select Analog Output Current Range)
ZERO (Set Zero Scale Temperature)
FULL (Set Full Scale Temperature)
Fatl (Set Output Current for Sensor or DWD Error)
A–LO (Set Alarm Current Output for Temperature Below ZERO)
A–HI (Set Alarm Current Output for Temperature Above FULL)

DIAG (Diagnostics List)

Status (Alarms and Measurement Status)
I Temp (Instrument Case Temperature)
Switch (Switch Contact State)
Emissivity or E–Slope (Value Monitor)

9.8 DPM Quick Programming Mode

9.8.1 Quick Programming

Two choices of programming are provided, Full and Quick Programming. The meter is supplied with a jumper inserted (or user switch installed) between terminals 7 and 8. This puts the DPM in the Quick Programming mode. This mode provides quick access to the Ircon parameter menus, Setpoint value inputs and ability to access additional meter programming by entering Code 222. Quick Programming is illustrated below. Full Programming is discussed in Section 9.13 DPM Sensor Diagnostic Functions, page 174.

9.8.2 Menu Navigation

Programming pushbuttons are provided for programming and navigation. Instructions are provided for selecting and adjusting menus and parameters in each of the operating sections that follow.

- Press DSP (Display) for the Temperature Display at any time.
- Continually pressing PAR sequences through all the menus and back to Temperature Display

Display	Parameter Description	Selections	Navigation and Information
IrCON no	Entry to IRCON Parameter Menus with F1 ▲ – F2 ▼ **OR** Entry to Setpoint Value settings and DPM Menus with PAR Key		Signifies choice of Ircon Parameters Menus DPM Setpoint and Entry Code Menus
		HEAd	F1 ▲ – F2 ▼ then PAR for Entry to HEAD
		Engr	F1 ▲ – F2 ▼ then PAR for Entry to ENGR
		AOUt	F1 ▲ – F2 ▼ then PAR for Entry to AOUT (ANALOG OUT.)
		diAG	F1 ▲ – F2 ▼ then PAR for Entry to DIAG (DIAGNOSTICS)
		no	**OR** Use PAR to select a Setpoint or Code or END Setpoint Values with F1/F2 Arrows
		SP-1	Enter Setpoint 1 Value
		SP-2	Enter Setpoint 2 Value
		SP-3	Enter Setpoint 3 Value
		SP-4	Enter Setpoint 4 Value
		CodE	Enter Code 222 to access meter set up programming menus
		End	Returns to Temperature Display (DSP)

9.9 DPM Temperature Display Mode

- Press DSP (Display) for the Temperature Display at any time.
- Press PAR to go to Quick Programming Model.

Display	Description	Selections	Navigation and Information
Error	No Sensor Communication Note: Quad Relays not held.		Insure Sensor Baud Rate BRAT – Set to 9600 Insure Sensor cable attached at both ends and powered.
tEMP	Valid temperature reading or special displays for Sensor and Measurement condition	9999 SEnSr InU t-HI t-LO CAL	**Numeric Reading** – Valid Temp **Sensor Failure** **Invalid Reading** (INV 1) **Temperature Above Sensor Range** **Temperature Below Sensor Range** **Calibration in Progress** (Quad Relays Held in Last State)

9.10 Engineering Menu

- Press DSP (Display) for the Temperature Display at any time.
- Continually pressing PAR sequences through all the menus and back to IRCON NO Menu entry start point.

ENGR Menu

Use Par to read next Parameter. Press PAR again to go next parameter without changing the value.
To Change a Value or Selection, use F1 ▲ – F2 ▼ , then **Press PAR to enter and save**

Display	Parameter Description	Selections	Navigation
LOC	Sensor Rear Panel Keyboard Lock	NO YES	Locks Sensor rear panel Keyboard. Parameters can be viewed at Sensor, but not changed. LOCK THE KEYBOARD IF THE DPM IS THE ONLY INTERFACE THAT WILL SETUP SENSOR.
MODL	Sensor Model	Sr- 14 1000	Eight Characters (Read Only) A SR Model example shown.
F / C	Measurement Units Selection	F C	Selects units to be used for display. Use matching units display overlay provided. See Figure 102 in this Section. See Section 5.6 ENGR – Setup of Engineering Functions, page 94 of manual for further instructions.
rELY	Relay Polarity	N C N O	Set the relay operation to correspond to proper and safe use of the contacts in the process system. Select N C. for closed relay operation with Sensor not in Alarm condition (open in alarm state). Select N.O. for closed relay operation with Sensor in Alarm condition (open when not in alarm condition). Normally closed operation is considered fail-safe operation.
IALM	Invalid Measurement Condition Alarm	OFF ON	ON selects Invalid Condition as ALARM to activate Alarm relay and rear panel ALARM display. OFF = Invalid is not alarm condition.
CHK	System Check	NO YES	Initiates Sensor internal circuit and detector check. Do not initiate Check with active Alarm(s) for Error Codes X103, X104, X105, and X106. See Section 5.6 ENGR – Setup of Engineering Functions, page 94.
----	Checking Cal		Displayed during check. (Read Only).
PASS	Check Passed		May be displayed after check. (Read Only).
FAIL	Check Failed		May be displayed after Cal check. (Read Only). Check DPM Diagnostics Section for Alarm Status and Section 7 Maintenance, page 127.
HOUR	Time before next Auto CHK in Hours	0-9999 Models 52, 5G, and 5R 0 or 168 Model 56 only	0 = OFF, no timed Automatic Check. Other Numerical value sets interval between Automatic Calibration checks. **Important: See recommendations in section 5.6.7 HOUR– Automatic Calibration Check, page 99.**
WARN	Dirty Window Detector Setup	OFF CORS SENS	Appears if Dirty window option installed. OFF turns, dirty window detection off. Coarse and Sensitive Warning Levels select a greater (CORS) or lesser (SENS) amount of Sensor window transmission loss to trigger alarm.
LASR	Laser Energize **See Safety Instructions in Sections 9.3. and 5.11.**	YES NO	Appears if Dirty window option installed. OFF turns, dirty window detection off. Coarse and Sensitive Warning Levels select a greater (CORS) or lesser (SENS) amount of Sensor window transmission loss to trigger alarm.
VER	Software Version	99 99	Reports Sensor firmware version (Read Only).

9.11 Sensor Setup Head Menu

- Press DSP (Display) for the Temperature Display at any time.
- Continually pressing PAR sequences through all the menus and back to **IRCON NO** Menu entry start point.

HEAd Menu

Use Par to read next Parameter. Press PAR again to go next parameter without changing the value .
To Change a Value or Selection, use F1 ▲ – F2 ▼, then **Press PAR to enter and save**☐

Display	Parameter Description	Selections	Information
EMIS	Emissivity	0.00 - 1.000	Sets Emissivity for single color units or ratio sensors in one color mode.
E-SL	E-Slope	0.800 - 1.200	Sets the E-Slope for Ratio Sensors in the 2-color ratio mode.
r.t.	Response Time	0.00 - 60.00 0.01 - 60.00 0.02 - 60.00	Sets the Sensor Response Time. **Model 52 and 5G Sensors:** Value 00.0 equals 6.6 milliseconds. **Model 5R Sensors Minimum: .01 seconds** **Model 56 Sensors Minimum: .02 seconds**
SIGL	Signal Conditioning	OFF trAV PEAV	Turns Peak Picker or Track and Hold Signal Conditioning on or off.
Sub Menu PSEL and its functions only appear if Peak Picker Signal Conditioning is selected.			
PSEL	Peak Selector Parameters	NO YES	Yes provides entry into sub-menu below.
d.r.	Peak Picker Decay Rate in degrees C or F. Press RST Key and F1 or F2 simultaneously to quickly change value	0.00 - 300.00 (F) or 0.00 - 166.66 (C)	Sets the peak picker decay rate in F or C. Zero (0) sets the unit to never decay. **Caution:** Sensors with firmware versions less than 1.02 have unit-less degrees that range 0.00 to 300.00 for both F and C units. See Section 5.10.1 D.R. – Decay Rate Function, page 108. for more information.
rSEt	Manual Peak Picker Reset	NO YES	Resets Peak Picker Operation.
AUtO	Auto Peak Picker Reset	NO YES	Selects Peak Picker Auto Reset operation.
rbEL	Peak Picker Reset Below. Appears if Auto Peak Picker Reset is On	600- 1400	Sets the temperature above which Peak Picker action starts with Auto Peak Picker Reset Function On.
dEL	Peak Delay	0.00 - 10.00	Sets the Delay Time in seconds before Peak Picker action starts after a Reset or from zero scale. Zero (0) turns Delay Time to Off.
COLr	Color Mode	1 2	Selects One Color (1) or Two Color (2) operation for a Series 5R ratio Sensor.
MtCH	Match	YES NO	Yes to Match known target temperature value to be displayed by Sensor.
MtCH	Match Sub-Menu **The Response Time should be set to 100 milliseconds or faster, and Peak Picker or Track and Hold set to Off during adjustment.**	2000	Sets temperature value to be displayed by Sensor to match known target temperature. If match requires an out of range E-slope or Emissivity, **Error** is displayed following the entry.

9.12 Sensor Setup Analog Output Functions

- Press DSP (Display) for the Temperature Display at any time.
- Continually pressing PAR sequences through all the menus and back to IRCON NO Menu entry start point.

AOUt Menu

Use Par to read next Parameter. Press PAR again to go next parameter without changing the value.
To Change a Value or Selection, use F1 ▲ – F2 ▼ , then **Press PAR to enter and save**

Display	Parameter Description	Selections	Navigation
SOUt	Analog Output Range	0-20 4-20	Sets Analog Output to 0 to 20 ma or 4 – 20 ma ☐
ZERO	Analog Output Zero Scale (4 or 0 mA) equivalent temperature	600- 1390	Minimum Sensor Temperature to Maximum Sensor Temperature minus 10°F or 10°C Minimum Zero to Full range must be 10 degrees. Example Shown for a 600 to 1400°F Range See note below about F and C conversions.
FULL	Analog Output Full Scale (20 mA) equivalent temperature	610- 1400	Minimum Sensor Temperature +10°F or 10°C to Maximum Sensor Temperature. Minimum Zero to Full range must be 10 degrees. Example Shown for a 600 to 1400°F Range See note below about F and C conversions.
FAtL	Analog Output during Fatal Alarm	0.0-24.0	Analog Current Output for Sensor Alarm Condition
A-LO	Analog Output Low Temperature	0.0-4.0	Analog Current Output for below Zero Temperature Condition. Will not appear for 0 – 20 mA output range
A-HI	Analog Output High Temperature	20.0 - 24.0	Analog Current Output for above Full Scale Temperature Condition

ZERO and FULL adjustments are limited to a 10°F or 10°C when using the DPM. Sensors with firmware Versions 1.3 can have °C units spans less than 10° because the Sensor first calculates in °F and then converts to °C. The equivalent °C span is allowed but must be set at the Sensor.

Spans more than 30°C (60°F) may be required to obtain acceptable results. Longer response times may be necessary for very narrow spans to smooth magnified temperature variations and noise.

9.13 DPM Sensor Diagnostic Functions

- Press DSP (Display) for the Temperature Display at any time.
- Continually pressing PAR sequences through all the menus and back to IRCON NO Menu entry start point.

d IAG Menu

Use Par to read next Parameter. Press PAR again to go next parameter without changing the value.
To Change a Value or Selection, use F1 ▲ – F2 ▼ , then **Press PAR to enter and save**

Display	Parameter Description	Readings	Navigation and Information
StAt	Status i The Measurement Status and Alarms are multiplexed on the display, one at a time, in a repeating loop. The display update is set at a faster rate to speed up the viewing of all alarms. In the Display Mode: When an Alarm condition occurs, the ALM indictor on the DPM Meter Flashes.	CAL-E INV-1 C-LO C-HI d-CLd d-HOt LOOP dirty SENSr dWd INV-2	**Alarms and equivalent Sensor Display Error Codes** **Out of Calibration Error**; Same as Error Code X102 **Signal Invalid 1**; Same as Error Code (INV) **Case Temp Low**; Same as Error Code X106 **Case Temp High**; Same as Error Code X105 **Detector Cold**; Same as Error Code X104 **Detector Hot**; Same as Error Code X103 **Current Loop Failure**; Same as Error Code X108 **Dirty Window Detected**; Same as Error Code X101 **Sensor Failure**; Same as Error Code X107 **DWD Failure**; Same as Error Code X109 **Signal Invalid 2**; Same as Error Code (pINV)
		NONE CLCP t-LO t-HI LASEr CAL	**Measurement Condition Status** **No Alarm** **RS485 Lock**; Sensor in Read Only Mode **Under-range**; Same as LOW on Sensor rear panel display **Over-range**; Same as HIGH on Sensor rear panel display **Laser Pointer On**; Same as LED lit on Sensor rear panel **Calibration in Progress**, Same as Cal on Sensor display
Emi IS or E-SL	Remote Emissivity or E-Slope input monitor	0.01-1.00 0.85-1.20	Emissivity or E-Slope Values monitored as remotely inputed, a slow scan function.
itMP	Instrument Internal Case Temperature	10 to 63	Instrument Temperature in selected units (C/F).
SWCh	Peak Picker Reset or Track and Hold Switch Status	OPEN CLOSE	Indicates the remote input switch condition, open or closed.

9.14 Full Programming Mode

Setpoints, MAX and MIN Displays, Overlay Backlight

Reference the Red Lion Inc. PAX – P Bulletin supplied with the meter for complete programming instructions for the DPM.

9.14.1 Full Programming

Using the PAR Key, select Code and Enter 222, then Press PAR. The DPM meter is now in Full Programming Mode. Depressing PAR displays the meter menus indicated below.

Only the modules, and the parameters appearing in the modules, are available to users. The DPM is a custom meter and several parameters are for dedicated use.

Module 1 – IRCON No (IRCON Programming also accessed in Quick Programming, replaces Signal Input Module)

Module 2 – User Input and Front Panel Function Key Parameters
Module 3 – Display and Program Lock-out Parameters
Module 4 – Secondary Function Parameters
Module 5 – Totalizer (Integrator Parameters) (Not available on the Ircon DPM)
Module 6 – Setpoint (Alarm) Parameters
Module 7 – Serial Communications Parameters (Baud must be set 9600, Data 8)
Module 8 – Analog Output Parameters (Not available on the Ircon DPM)
Module 9 – Factory Service Operations

9.14.2 Quad Relay Card Setpoint Basic Setup and Operation

The operation described is with the DPM in the Quick Programming Mode. Refer to the PAX Bulletin PAXCDS-C supplied with the Quad Relay Card for Setpoint operation variations with different setups. Refer to the PAXP Bulletin for Module 3 Setup in Section 6.3 Communication Protocol, page 116.

Module 3 – Display and Program Lock-out Parameters (3 - LOC)

Do not change **tot** parameter. Set the following seven parameters.

HI to LOC Then LO to LOC Then SP-1 to ENt Then SP-2 to ENt Then SP-3 to ENt Then SP-4 to ENt Then CodE to 222

(If using MAX or MIN temperature display HI or LO may require different setup.)

Module 6 – Setpoint (Alarm) Parameters (6 - SPt)

Do not change parameters **SP-n**, **HYS-n**, **tON-n**, **tOF-n**, **rST-n**, **Stb-n**. Set the following four parameters.

SPSEL 1 Then Act to AB HI Then out to nor Then LIF to nor

To Program Setpoint 2:

SPSEL 2 Then Act to AB HI Then out to nor Then LIF to nor

Repeat setup above for Setpoints 3 and 4.

Setpoint temperature values are entered in the Quick Programming Mode. Par key must be pressed to enter values.

This setup leaves all other parameters at the factory default values. These parameters should be reviewed and changed to match the process requirements using the PAX bulletins.

Operation:
Setpoint temperature values are inputted in the Quick Programming Mode using the PAR Key to quickly access and change them. Setpoint relay action occurs when displayed temperature is above the Setpoint value. Setpoint alarm annunciators on the DPM display also light. Output logic is normally open.

Setpoints are only operational when the DPM is in the Display mode. The Setpoint relay outputs are held in their last state before leaving the display mode and entering any programming or diagnostic mode. Relays also held in their last state during Sensor CAL (Calibration in progress).

Relay states will be in an unknown condition with a Sensor error.

9.14.3 MAX and MIN Temperature Display Basic Setup and Operation

The operation described is with the DPM in the Quick Programming Mode. Refer to the PAX Bulletin supplied with the meter for MAX and MIN operation variations with different setups. This Setup displays captured MAX and MIN in the Quick Programming mode by pressing Display function key to choose MAX, MIN or Current Temperature

Setup
Module 2 – User Input and Front Panel Function Key Parameters (2 - FNC)

Do not change **User 1** parameter leave at **PLOC**. Do not change **ScF1** or **ScF2**, leave at **NO**.

Set USEr 2 to d-Lo Then USEr 3 to d-HI Then F1 to r-HI Then F2 to r-Lo

Then rSF to r-HL

Module 3 – Display and Program Lock-out Parameters (3 - LOC)

Set HI to rEd Then LO to rEd
All other parameters remain at the factory default settings.

Operation:
Press Display (DSP) function key to choose MAX, MIN or current Temperature. The MAX and MIN temperatures have been captured since the last reset of these functions.

The Front Panel F1 Key resets the MIN value to the current temperature reading on the display. The MIN temperature function continues from that point.

The Front Panel F2 Key resets the MAX value to the current temperature reading on the display. The MAX temperature function continues from that point.

The Front Panel RST Key resets both MAX and MIN values to the current temperature reading on the display.

9.14.4 Overlay Backlight

The DPM is factory set for using an F or C units display overlay. If an overlay is not used, the backlight can be turned off in the Full Programming as follows.

Module 4 Secondary Functions (4 - SEC)
Only change the b-Lit parameter. Change to On.

9.15 Factory Default Restoration

If for some reason the DPM settings have been changed and set to values that are now unknown, restoration to factory settings can be made. Access to Module 9 – Factory Service Operations, is required. Refer to the Red Lion PAX –B Bulletin for complete instructions.

To access Factory Service from the Quick Programming Mode, display the CodE parameter and enter 222.

Alternately, with the User – 1 jumper between Terminals 7 and 8 removed, the unit is in Full Programming mode and access to all meter programming modules is immediately available. Remove the jumper only as an alternate to the Code 222 entry in the Quick Programming Mode.

Select Module 9 – Factory Service Operations. Go to Code. Enter CodE 66. The meter will display "reset" and return the display to 50. This will overwrite all user settings to the factory settings. If removed, replace the jumper between terminals 7 and 8. Test the meter to make sure it is back in the correct mode of operation. **Setpoint and MIN / MAX parameters need to be programmed again.**

Appendix A

10 Appendix A

NEMA SAFETY GUIDELINES

for the Application, Installation and Maintenance of Solid-State Control

SECTION 1: DEFINITIONS

(This section is classified as NEMA Standard 11-15-1984.)

Electrical Noise—Unwanted electrical energy which has the possibility of producing undesirable effects in the control, its circuits, and system.

Electrical Noise Immunity—The extent to which the control is protected from a stated electrical noise.
Off-State Current—The current that flows in a solid state device in the off-state condition.

Off-State Condition—The conditions of a solid-state device where no control signal is applied.

On-State Condition—The condition of a solid-state device when conducting.

Surge Current—A current exceeding the steady state current for a short time duration, normally described by its peak amplitude and time duration.

Transient Over-voltage—The peak voltage in excess of steady state voltage for a short time during the transient conditions (e.g., resulting from the operations of a switching device).

SECTION 2: GENERAL

(Sections 2 through 5 are classified as Authorized Engineering Information 11-15-1984.)

Solid State and electro-mechanical controls can perform similar control functions, but there are certain unique characteristics of solid state controls which must be understood. In the application, installation and maintenance of solid state control, special consideration should be given to the characteristics described in 2.1 through 2.7.

2.1 Ambient Temperature

Care should be taken not to exceed the ambient temperature range specified by the manufacturer.

2.2 Electrical Noise

Performance of solid-state controls can be affected by electrical noise. In general, complete systems are designed with a degree of noise immunity. Noise immunity can be determined with tests such as described in 3.4.2. Manufacturer recommended installation practices for reducing the effect of noise should be followed.

2.3 Off-State Current

Solid-state controls generally exhibit a small amount of current flow when in the off-state condition. Precautions must be exercised to ensure proper circuit performance and personnel safety. The value of this current is available from the manufacturer.

2.4 Polarity

Incorrect polarity of applied voltages may damage solid-state controls. The correct polarity of solid-state controls should be observed.

2.5 Rate of Rise – Voltage or Current DV/DT or DI/DT)

Solid-state controls can be affected by rapid changes of voltage or current if the rate of rise (DV/DT and/or DI/DT) is greater than the maximum permissible value specified by the manufacturer.

2.6 Surge Current

Current of a value greater than that specified by the manufacturer can affect the solid-state control. Current limiting means may be required.

2.7 Transient Over-voltage

Solid-state controls may be affected by transient over-voltages that are in excess of those specified by the manufacturer. Voltage limiting means should be considered and may be required.

SECTION 3: APPLICATION GUIDELINES

3.1 General Application Precautions

3.1.1 Circuit Considerations

The consequences of some malfunctions such as those caused by shorted output devices, alteration, loss of memory, or failure of isolation within components or logic devices require that the user be concerned with the safety of personnel and the protection of the electronics.

It is recommended that circuits which the user considers to be critical to personnel safety, such as "end of travel" circuits and "emergency stop" circuits, should directly control their appropriate functions through an electromechanical device independent of the solid-state logic. Such circuits should initiate the stop function through de-energization rather than energization of the control device. This provides a means of circuit control that is independent of system failure.

3.1.2 Power Up/Power Down Considerations

Consideration should be given to system design so that unsafe operation does not occur under these conditions since solid state outputs may operate erratically for a short period of time after applying or removing power.

3.1.3 Redundancy and Monitoring

When solid-state devices are being used to control operations which the user determines to be critical, it is strongly recommended that redundancy and some form of checking be included in the system. Monitoring circuits should check that actual machine or process operation is identical to controller commands; and in the event of failure in the machine, process, or the monitoring system, the monitoring circuits should initiate a safe shutdown sequence.

3.1.4 Over-current Protection

To protect triacs and transistors from shorted loads, a closely matched short circuit protective device (SCPD) is often incorporated. These SCPD's should be replaced only with devices recommended by the manufacturer.

3.1.5 Over-voltage Protection

To protect triacs, SCR's and transistors from over-voltages, it may be advisable to consider incorporating peak voltage clamping devices such as arrestors, zener diodes, or snubber networks in circuits incorporating these devices.

3.2 Circuit Isolation Requirements

3.2.1 Separating Voltages

Solid-state logic uses low level voltage (e.g., less than 32 volts dc) circuits. In contrast, the inputs and outputs are often high level (e.g., 120 volts ac) voltages. Proper design of the interface protects against an unwanted interaction between the low level and high level circuits; such an interaction can result in a failure of the low voltage circuitry. This is potentially dangerous. An input and output circuitry incorporating effective isolation techniques (which may include limiting impedance or Class 2 supplied circuitry) should be selected.

3.2.2 Isolation Techniques

The most important function of isolation components is to separate high level circuits from low level circuits in order to protect against the transfer of a fault from one level to the other. Isolation transformers, pulse transformers, reed relays, or optical couplers are typical means to transmit low level logic signals to power devices in the high level circuit. Isolation impedance means also are used to transmit logic signals to power devices.

3.3 Special Application Considerations

3.3.1 Converting Ladder Diagrams

Converting a ladder diagram originally designed for electromechanical systems to one using solid-state control must account for the differences between electromechanical and solid state devices. Simply replacing each contact in the ladder diagram with a corresponding solid state "contact" will not always produce the desired logic functions or fault detection and response. For example, in electromechanical systems, a relay having a mechanically linked normally open (NO) and normally closed (NC) contact can be wired to check itself. Solid-state components do not have a mutually exclusive NO-NC arrangement.

However, external circuitry can be employed to sample the input and "contact" state and compare to determine if the system is functioning properly.

3.3.2 Polarity and Phase Sequence

Input power and control signals should be applied with polarity and phase sequence as specified by the manufacturer. Solid-state devices can be by the application of reverse polarity or incorrect phase sequence.

3.4 Planning Electrical Noise Rejection

The low energy levels of solid-state controls may cause them to be vulnerable to electrical noise. This should be considered in the planning stages.

3.4.1 Assessing Electrical Environment

Sources of noise are those pieces of equipment that have large, fast changing voltages or currents when they are energized or de-energized, such as motor starters, welding equipment, SCR type, adjustable speed devices, and other inductive devices. These devices, as well as the more common control relays and their associated wiring, all have the capability of inducing serious current and voltage transients on their respective power lines. It is these transients which nearby solid state controls must withstand and for which noise immunity should be provided.

An examination of the proposed installation site of the solid-state control should identify equipment that could contaminate power lines. All power lines that will be tapped by the proposed solid state control should be examined for the presence, severity, and frequency of noise occurrences. If found, system plans should provide for the control of such noise.

3.4.2 Selecting Devices to Provide Noise Immunity

Installation planning is not complete without examination of the noise immunity characteristics of the system devices under consideration. Results of tests to determine relative immunity to electrical noise may be required from the manufacturer. Two such standardized tests are the ANSI (C37.90a-1974) Surge Withstand Capability test and the NEMA (ICS 1-1983) noise test referred to as The Showering Arc Test. These are applied where direct connection of solid state control to other electromechanical control circuits is intended. Circuits involving analog regulating systems or high speed logic are generally more sensitive to electrical noise; therefore, isolation and separation of these circuits is more critical.

Further information on electrical noise and evaluation of the severity of noise may be found in ANSI/IEEE Publication No. 518-1982. Where severe power line transients are anticipated or noted, appropriate such as commercially available line filter, isolation transformers, or voltage limiting varistors, should be considered. All inductive components associated with the system should be examined for the need for noise suppression.

3.4.3 Design of Wiring for Maximum Protection

Once the installation site and power conductors have been examined, the system wiring plans that will provide noise suppression should be considered.

Conducted noise enters solid state control at the points where the control is connected to input lines, output lines, and power supply wires. Input circuits are the circuits most vulnerable to noise. Noise may be introduced capacitatively through wire-to-wire proximity or magnetically from nearby lines carrying large currents. In most installations, signal lines and power lines should be separate. Further, signal lines should be appropriately routed and shielded according to the manufacturer's recommendations. When planning a system layout, care must be given to appropriate grounding practice. Because design differences may call for different grounding, the control manufacturer's recommendations should be followed.

3.5 Countering the Effects of Off-State Current

3.5.1 Off-State Current

Solid-state components, such as triacs, transistors and thyristors inherently have in the off-state a small current flow called "off-state current". Off-state current may also be contributed by devices used to protect these components, such as RC snubbers.

3.5.2 Off-State Current Precautions

Off-state currents in a device in the off-state may present a hazard of electrical shock and the device should be disconnected from the power source before working on the circuit or load. Precautions should be taken to prevent the off-state current of an output device which is in the off-state from energizing an input device.

3.6 Avoiding Adverse Environmental Conditions

3.6.1 Temperature

Solid-state devices should only be operated within the temperature ranges specified by the manufacturer. Because such devices generate heat, care should be taken to see that the ambient temperature at the device does not exceed the temperature range specified by the manufacturer.

Appendix A

The main source of heat in a solid-state system is the energy dissipated in the power devices. Since the life of the equipment can be increase by reducing operating temperature, it is important to observe the manufacturer's "maximum/minimum ambient temperature" guidelines, where ambient refers to the temperature of the air providing the cooling. The solid-state equipment must be allowed to stabilize to within the manufacturer's recommended operating temperature range before energizing control functions.

When evaluating a system design, other sources of heat in the enclosure which might raise the ambient temperature should not be overlooked. For example- power supplies, transformers, radiated heat, sunlight, furnaces, incandescent lamps, etc. should be evaluated.

In instances where a system will have to exist in a very hot ambient environment, special cooling methods may have to be employed. Techniques that are employed include cooling fans (with adequate filtering), vortex coolers, heat exchanges and air conditioned rooms. Over-temperature sensors are recommended for systems where special cooling is employed. Use of air conditioning should include means for prevention of condensing moisture.

3.6.2 Contaminants

Moisture, corrosive gases and liquids, and conductive dust can all have adverse effects on a system that is not adequately protected against atmospheric contaminants. If these contaminants collect on printed circuit boards, bridging between the conductors may result in malfunction of the circuit. This could lead to noisy, erratic control operation or at worst, a permanent malfunction.

A thick coating of dust could also prevent adequate cooling on the board or heat sink, causing malfunction. A dust coating on heat sink reduces their thermal efficiency. Preventive measures include a specially conditioned room or a properly specified enclosure for the system.

3.6.3 Shock and Vibration

Excessive shock or vibration may cause damage to solid-state equipment. Special mounting provisions may be required to minimize damage.

3.7 Safety Knowledge Leads to Safety

Planning for an effective solid-state circuit requires enough knowledge to make basic decisions that will render the system safe as well as effective. Everyone who works with a solid-state control should be educated in its capabilities and limitations. This includes in-plant installers, operators, service personnel, and system designers.

SECTION 4: APPLICATION GUIDELINES

4.1. Installation

Proper installation and field wiring practices are of prime importance to the application of solid state controls. Proper wiring practice will minimize the influence of electrical noise which may cause malfunction of equipment. Users and installers should be familiar with installation and wiring instructions in addition to requirements of all applicable codes, laws and standards. The manufacturer of the device or component in question should be consulted whenever conditions arise that are not covered by the manufacturer's instructions.

Electrical noise is a very important consideration in any installation of solid-state control. While wiring practices may vary from situation to situation, the following are basic to minimizing electrical noise:

a). Sufficient physical separation should be maintained between electrical noise sources and sensitive equipment to assure that the noise will not cause malfunctioning or un intended actuation of the control.

b). Physical separation should be maintained between sensitive signal wires and electrical power and control conductors. This separation can be accomplished by conduits, wiring trays or as otherwise recommended by the manufacturer.

c). Twisted-pair wiring should be used in critical signal circuits and noise producing circuits to minimize magnetic interference.

d). Shielded wire should be used to reduce the magnitude of the noise coupled into the low level signal circuit by electrostatic or magnetic coupling.

e). Provisions of the 1984 "National Electrical Code" with respect to grounding should be followed. Additional grounding precautions may be required to minimize electrical noise. These precautions generally deal with ground loop current arising from multiple ground paths. The manufacturer's recommendations should be followed.

4.2 Enclosures (cooling and ventilating)

Suitable enclosures and control of the maximum operating temperature, both of which are environmental variables, may be needed to prevent malfunction of solid-state control.

Follow the manufacturer's recommendations for the selection of enclosures, ventilation, air filtering (if required, and ambient temperature. These recommendations may vary from installation to installation even within the same facility.

4.3 Special Handling of Electrostatic Sensitive Devices

Some devices may be damaged by electrostatic charges. These devices are identified and should be handled in the special manner specified by the manufacturer.

Plastic wrapping materials used to ship these devices may be conductive and should not be used as insulating material.

4.4 Compatibility of Devices with Applied Voltages and Frequencies

Users and installers should verify that the applied voltage and frequency agree with the rated voltage and frequency specified by the manufacturer.

Incorrect voltage or frequency may cause a malfunction or damage to the control.

4.5 Testing Precautions

When testing solid state control, the procedures and recommendations set forth by the manufacturer. When applicable, instrumentation and test equipment should be electrically equivalent to that recommended by the manufacturer for the test procedure. Do not use a low impedance voltage tester.

High voltage insulation tests and dielectric tests should never be used to test solid state devices. If high voltage insulation of field wiring is required, solid state devices should be disconnected. Ohm

meters should only be used when recommended by the manufacturer. Testing equipment should be grounded – if it is not, special precautions should be taken.

4.6 Start-up Procedures

Checks and tests prior to start-up and start-up procedures recommended by the manufacturer should be followed.

SECTION 5: PREVENTIVE MAINTENANCE and REPAIR GUIDELINES

5.1 General

A well planned and executed maintenance program is essential to the satisfactory operation of solid state electrical equipment. The kind and frequency of the maintenance operation will vary with the complexity of the equipment as well as with the nature of the operating conditions. The manufacturer's maintenance recommendations should be followed.

Useful reference publications for setting up a maintenance program are NFPA 70B-1983 "Maintenance of Electrical Equipment" and NFPA 70E-1983 "Electrical Safety Requirements for Employee Workplaces."

5.2 Preventive Maintenance

The following factors should be considered when formulating a maintenance program.

1. Maintenance should be performed by qualified personnel familiar with the construction, operation and hazards involved with the control.

2. Maintenance should be performed with the control out of operation and disconnected from all sources of power. If maintenance must be performed while the control is energized, the safety related practices of NFPA 70E should be followed.

3. Care should be taken when servicing electrostatic sensitive components. The manufacturer's recommendations for these components should be followed.

4. Ventilation passages should be kept open. If the equipment depends upon auxiliary cooling, e.g., air, water, or oil, periodic inspection (with filter replacement when necessary) should be made of these systems.

5. The means employed for grounding or insulating the equipment from ground should be checked to assure its integrity (see 4.5).

6. Accumulations of dust and dirt on all parts, including semiconductor heat sinks, should be removed according to the manufacturer's instructions, if provided; otherwise, the manufacturer should be consulted. Care must be taken to avoid damaging any delicate components and to avoid displacing dust, dirt, or debris that permits it to enter or settle into parts of the control equipment.

7. Enclosures should be inspected for evidence of deterioration. Accumulated dust and dirt should be removed from the top of the enclosures before opening doors or removing covers.

8. Certain hazardous materials removed as part of maintenance or repair procedure (e.g., polychlorinated biphenyls (PCB) found in some liquid filled capacitors) must be disposed of as described in federal regulations.

5.3 Repair

If equipment condition indicates repair or replacement, the manufacturer's instruction manual should be followed carefully. Diagnostic information within such a manual should be used to identify the probable source of the problem, and to formulate a repair plan. When solid-state equipment is repaired, it is important that any replacement part be in accordance with the recommendations of the equipment manufacturer.

Care should be taken to avoid the use of parts which are no longer compatible with other changes in the equipment. Replacement parts should be inspected for deterioration due to "shelf life" and for signs of rework or wear that may involve factors critical to safety. After repair, follow proper start-up procedures. Take special precautions to protect personnel from hazards during start-up.

5.4 Safety Recommendations for Maintenance Personnel

Qualified personnel familiar with the construction, operation and hazards involved, should do all maintenance work. The appropriate work practices of NFPA 70E should be followed.

11 Appendix B

DISASSEMBLY INSTRUCTIONS FOR DISPOSAL AND RECYCLING: IRCON MODLINE 5 SERIES PRODUCT AND ACCESSORIES

Following are the disassembly instructions for the IRCON Modline 5 Series product, including all optional accessories, in accordance to guidelines of the European Union Waste Electric and Electronic Equipment (WEEE) Directive 2002/96/EC.

This product includes the following materials to be dispensed of properly:

Aluminum	POI box casing, WJ-5 water jacket, various accessories
Steel	Sensor and Lens Housings, various screws and connectors
Plastic	Various components within sensor, DWD unit and POI box, cable coating
Printed Circuit Board	Circuitry within sensor and DWD unit
Silicone	Cable coating
Rubber	Gaskets

Fully Assembled View:
Below is a photograph of a fully-assembled Ircon Modline 5 series sensor. Disassembly instructions for this product series are shown on the following pages. These instructions account for all Modline 5 models (and often-used accessories), as the variation between models affecting recycling is minimal.

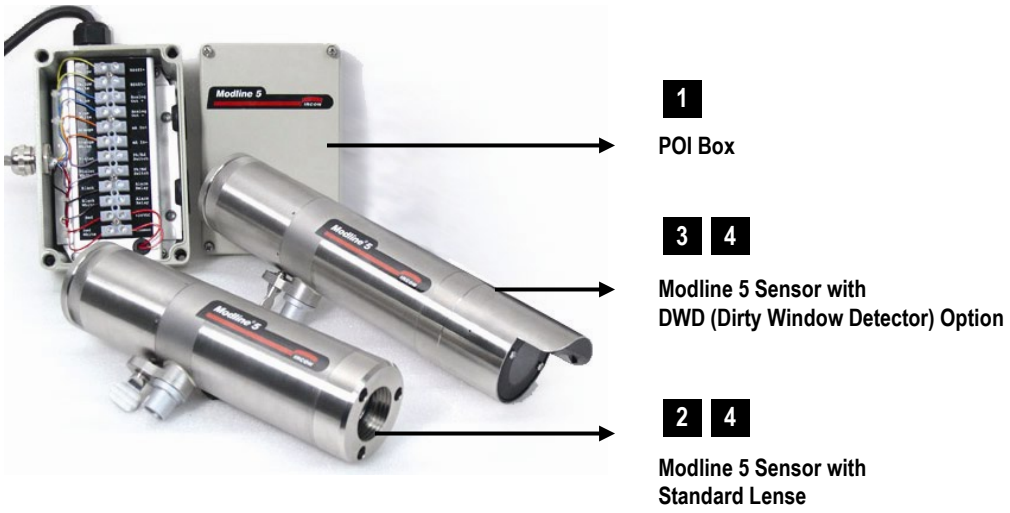


Figure 107: Fully Assembled View

DISASSEMBLY INSTRUCTIONS FOR DISPOSAL AND RECYCLING: IRCON MODLINE 5 SERIES PRODUCT AND ACCESSORIES

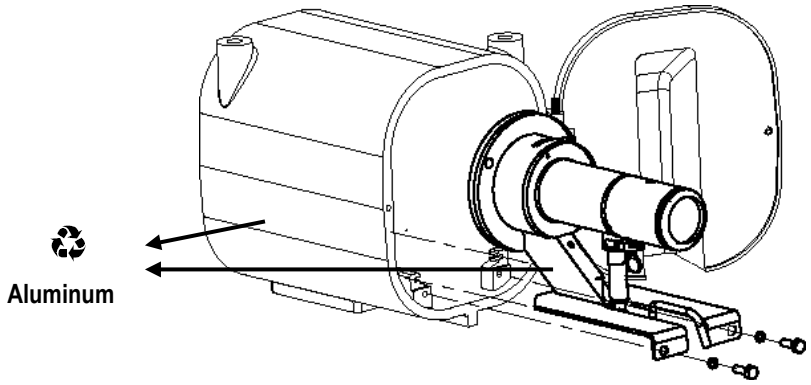


Figure 108: Modline 5 Sensor with WJ5 Cooling Jacket Accessory

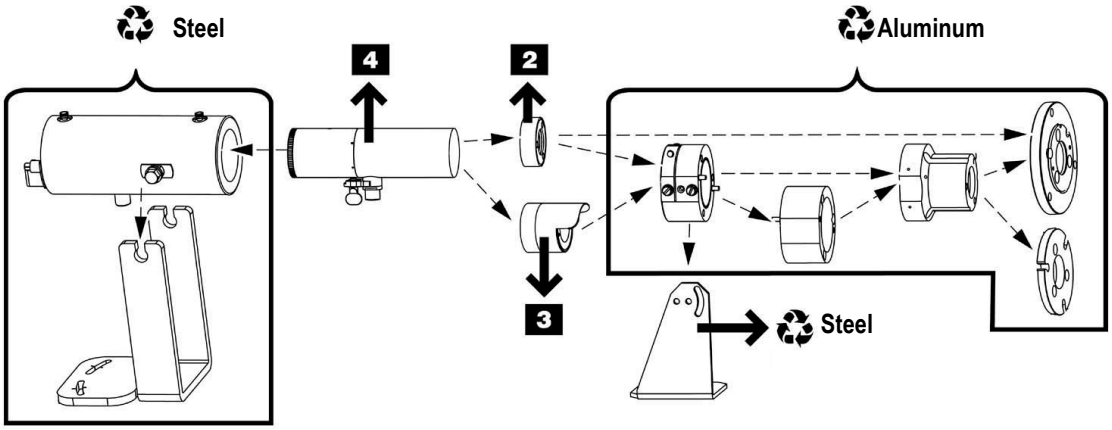
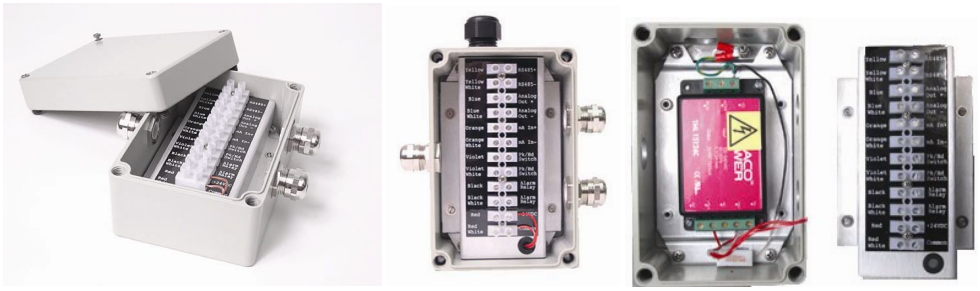


Figure 109: Modline 5 Sensors with WJA Cooling Jacket (Left) and other Accessories (Right)

Appendix B

DISASSEMBLY INSTRUCTIONS FOR DISPOSAL AND RECYCLING: IRCON MODLINE 5 SERIES PRODUCT AND ACCESSORIES

1 **Power Supply / Signal Interface Box (POI) Disassembly Instructions**



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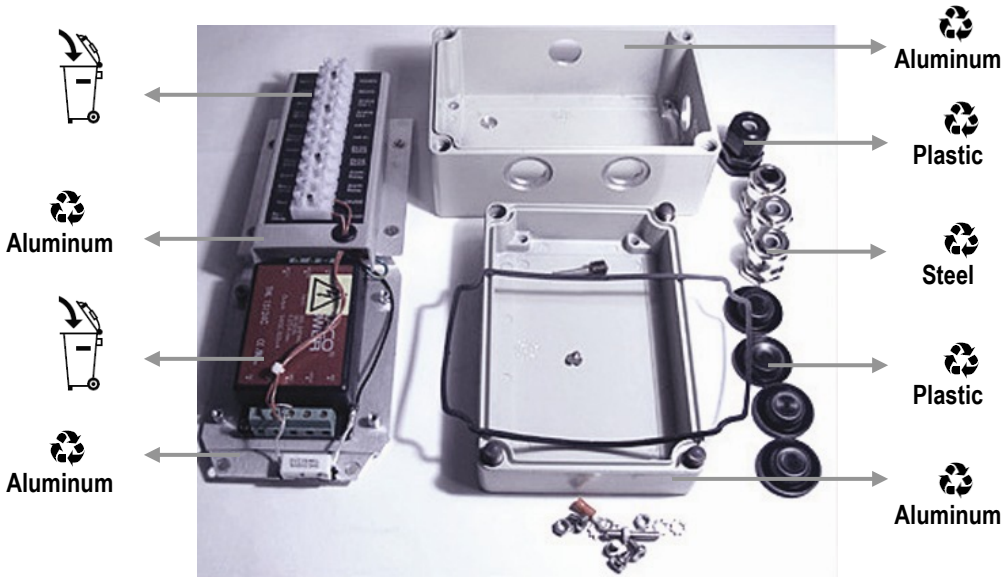
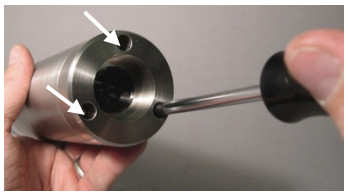


DISASSEMBLY INSTRUCTIONS FOR DISPOSAL AND RECYCLING: IRCON MODLINE 5 SERIES PRODUCT AND ACCESSORIES

2 **Removal of Modline 5 Sensor - Standard Lens**



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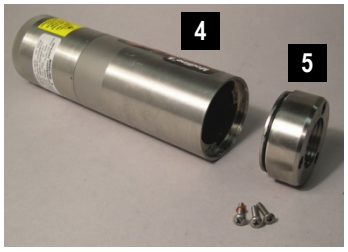

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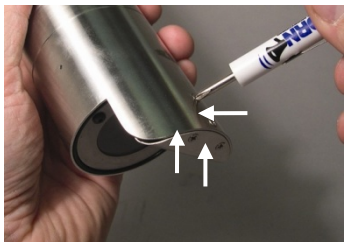
3 **Removal of Modline 5 Sensor – Lens with DWD (Dirty Window Detector) Option**



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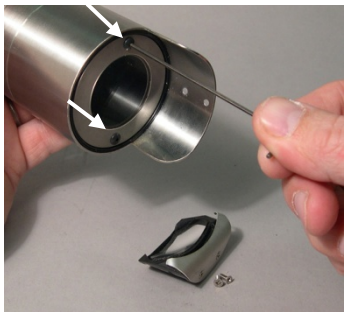

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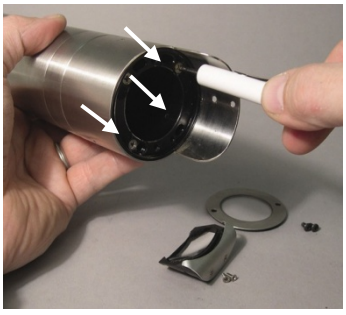

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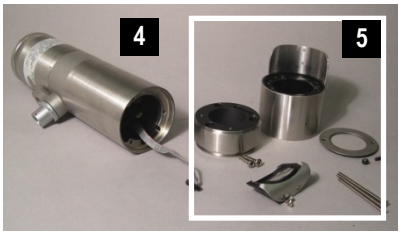

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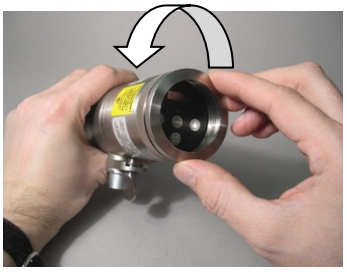
Appendix B

DISASSEMBLY INSTRUCTIONS FOR DISPOSAL AND RECYCLING: IRCON MODLINE 5 SERIES PRODUCT AND ACCESSORIES

4 **Disassembly of Sensor Body**



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DISASSEMBLY INSTRUCTIONS FOR DISPOSAL AND RECYCLING: IRCON MODLINE 5 SERIES PRODUCT AND ACCESSORIES

5 **Fully Disassembled Sensor**